the JOURNAL of environmental sciences

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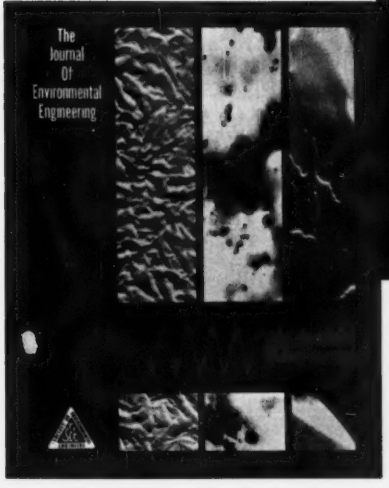

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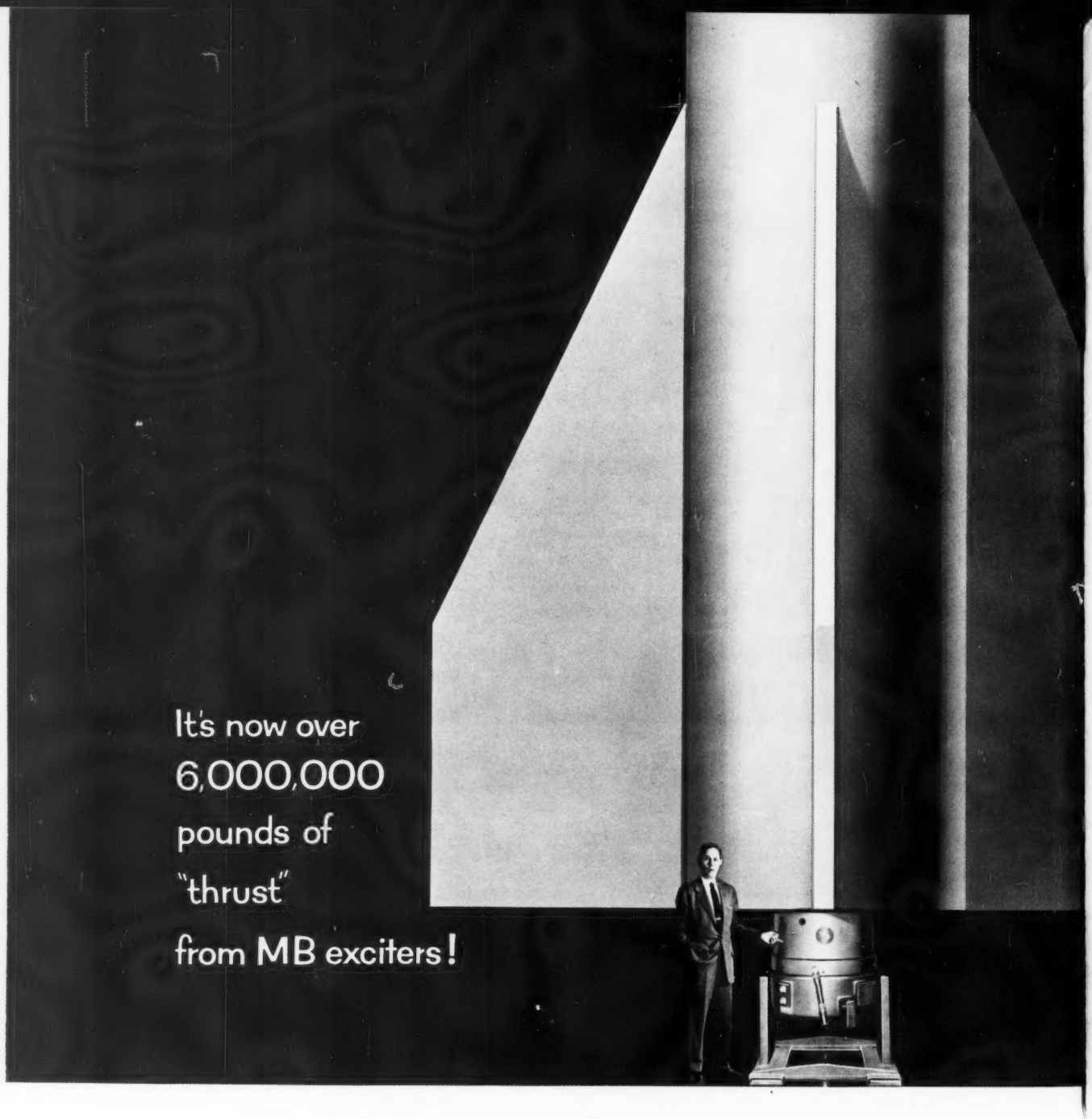

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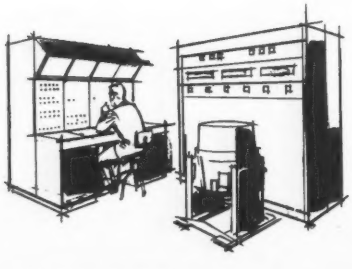

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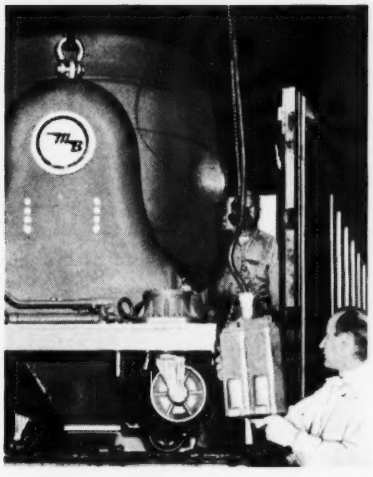

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the JOURNAL of environmental sciences

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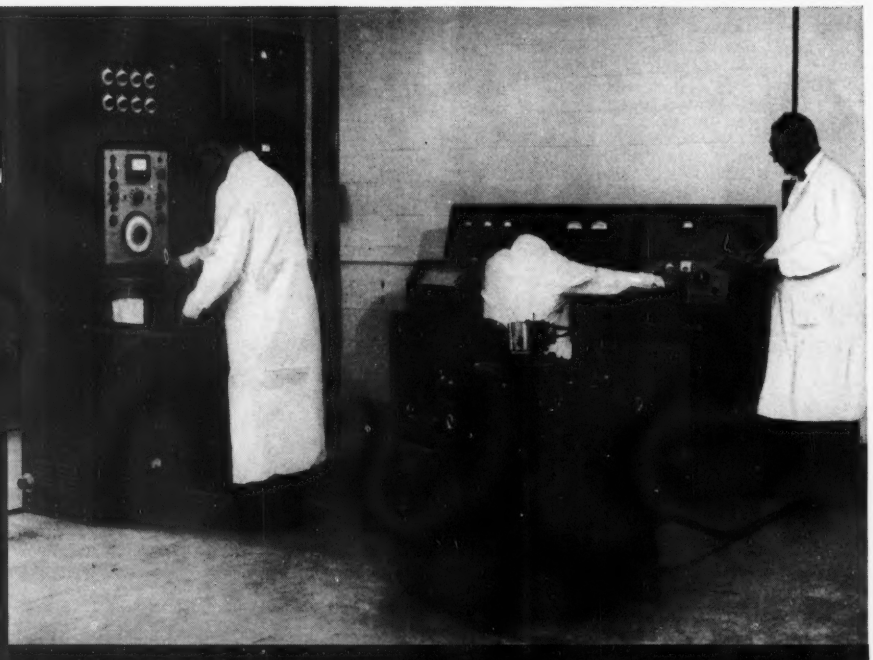

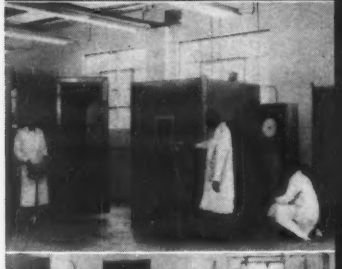

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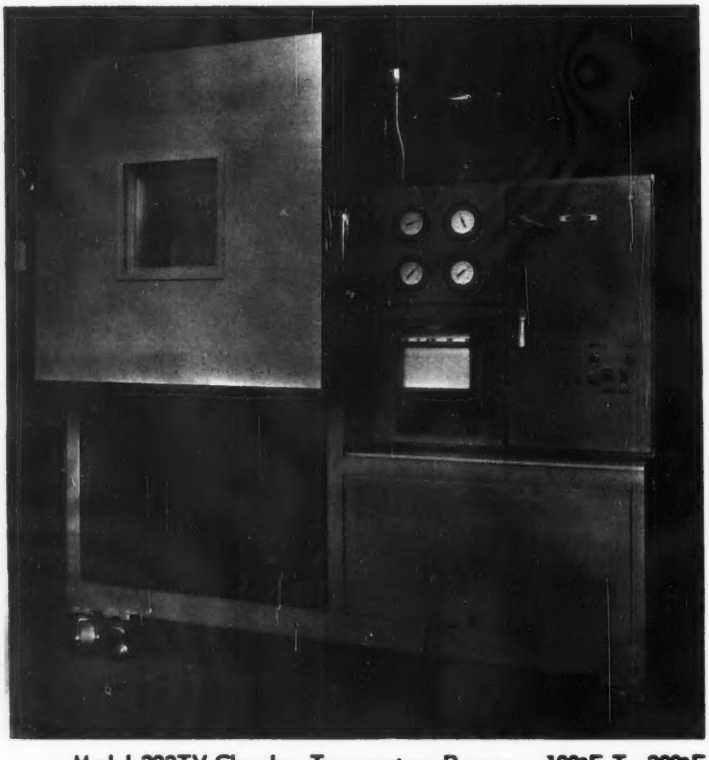

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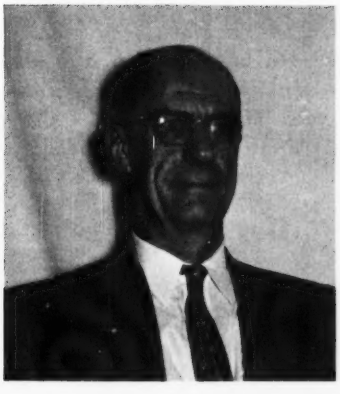
TRANSIENT HIGH TEMPERATURE SIMULATION

by



R. H. CANNING & **TANG YEE**

mat. and proc. engineer **sr. lab. technician**

CANNON ELECTRIC CO.

The Cannon Heat Flux Apparatus was designed to provide a source of radiant heat for testing Cannon Plugs which may be subjected to the heat conditions of re-entry of a missil. Missiles may pass thru the earths atmosphere at various planned angles. We are concerned here with steeper angles where the time is relatively short. For example we have a spec .which calls for a curve of heat change, within a time of only 40 seconds.

The quartz rod lamp is chosen for the heat source because of its rather convenient characteristics. The 500 watt 125 volt type was used. This lamp consists of a clear quartz tube three eighths inch diameter and about six inches long. A coiled tungsten filament runs thru most of the length of the tube.

The heat limitations of the lamp itself are the tungsten filament, which is of a high order, and the quartz envelope, which is also relatively high. The remaining problem is the sealing at each end of the tube where the filament wires enter. Here the temperature should be kept well below 600 degrees F.

Another desirable characteristic of the quartz lamp is that the power dissipated in the filament is instantly converted into radiant heat, largely in the infra red region. The response time is less than one second which makes for fast accurate control. This is essential where we have a spec calling for a rapidly rising and falling BTU content during 40 seconds.

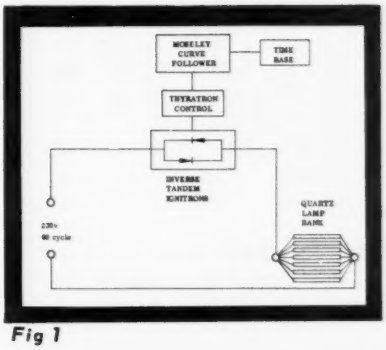


Fig 1

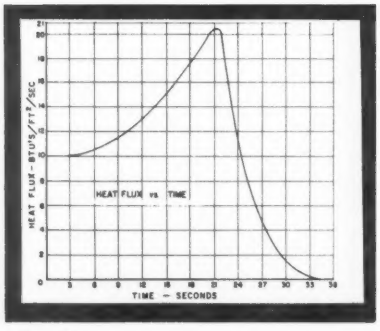


Fig. 3

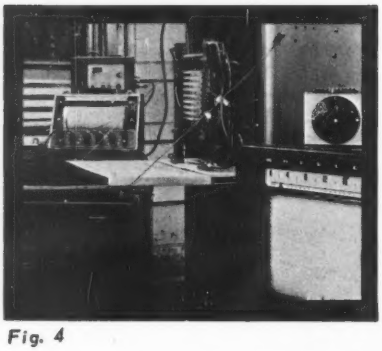


Fig. 4

Since the power required for this apparatus may reach about 30 KW a very flexible power supply and its controls are necessary. Referring to Fig. 1, it is noted that the 230 volt 60 cycle Single Phase line source feeds the quartz lamp bank thru two Ignitrons. These are connected in inverse tandem which merely means that there is an Ignitron control in the correct direction for each alternation of an individual cycle. The Ignitron is a mercury pool rectifier, used here as a unidirectional switch, capable of handling large currents. The additional, or firing, electrode provides a very precise control. The firing electrode's voltage is furnished by a pair of Thyratrons. The Thyratrons are in turn controlled by the servo system of a Moseley Curve Follower. This device is a recorder in which the pen has been replaced by a pickup coil which has the ability to follow a conductive ink line or curve on the paper. A Time Base is provided with a number of selected speeds which determine the chart drum speed which is the time axis of the final Heat Flux control curve.

Sequentially we place on the Curve Follower the curve of desired BTU output plotted against time. The Curve Follower feeds this curve into the Thyratrons. They in turn duplicate this at the Ignitron firing electrodes. Finally the Ignitrons deliver power to the Quartz Lamp bank in accordance with the original curve.

In detail, the Lamp Bank consists of nine of the three eighths inch diameter rods, as a front group, arranged horizontally in a vertical plane with three eighths inch separation between lamps.

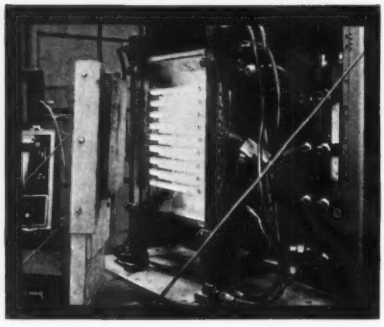


Fig. 2

The rear group of eight lamps are similarly arranged immediately behind the front bank and appear thru the spaces between the front lamps. Thus we have an array of 17 lamps presenting a radiant heat source concentrated in an area of six by six in.

Since the lamps radiate also to the rear a reflector was made to recover as much as possible of this radiation and direct it toward the front. The reflector is a hollow sheet copper tank with brazed seams and provided with water inlet and outlet fittings. The reflecting surface is flat with a slight curvature toward the lamps at the upper and lower edges. The copper surface was burnished and then plated with a heavy coat of Nickel which was also burnished. It was then plated heavily with 24 karat Gold and highly polished.

This reflector has been in use and has not tarnished or lost its reflecting ability. It requires only the occasional removal of dust with alcohol and tissue.

The lamp bank mounting provides, simultaneously, physical support and cooling for the lamp ends. These lamp ends are flat and intended to mount much in the same manner as blade type cartridge fuses. At each end of the lamp bank there are three uprights which consist of half by half inch square brass tubing. The lamp ends of the two rows of lamps are clamped in the spaces between the three hollow supports. The ends of the tubes each have brazed hose fittings to handle the cooling water. Because the lamp ends are not always exactly in line with each other and are rather delicate, the entire contact surface was covered with a winding of one sixteenth inch soft copper Belden braid. This afforded good heat conductivity and allowed for the squeezing necessary in mounting. The actual terminal wires of the lamps were brought together at two Burndy Terminals.

A 6 gallon plastic bottle is the reservoir for the distilled water system. A small "In line" impeller type pump furnishes about 5 gallons per minute flow. Cooling circuits consist of the lamp ends square tubing supports, the hollow reflector and the usual Ignitron water jackets. Electrical isolation is assured by using interconnecting lines of three eighths inch Neoprene hot water type hose. The over-all cooling is very good as there has been no deterioration of the reflector nor loss of lamps due to failure at the lamp ends.

Altogether this Heat Flux unit provides a serviceable radiant heat source with excellent control. Having provided the lamps and reflector with adequate cooling it is possible to take advantage of another interesting capability of the Quartz lamp. Doubling the voltage across these

125 volt 500 watt lamps triples the power. They can even be operated for brief periods at triple the rated voltage.

Since the power consumed is converted into radiant energy by the lamps and since one kilowatt is substantially equal to one BTU we next need to know the BTU's per area delivered to the specimen. Conveniently this should be in terms of lamp input voltage. Specification curves which are stated in BTU's can then be plotted for the curve follower directly from the voltage and power curves of the lamps. Readings for these curves are obtained with a thermocouple type voltmeter and ammeter because of the wave form output of the Ignitrons.

The next step is to determine the BTU's delivered to the sample in BTU's per square foot per second in terms of power input. The losses are mainly in the inability of the reflector to recover all the heat radiated to the rear.

A number of calorimeter methods were tried including water in a glass tank and in a blackened copper tank. These were unsatisfactory because of poor heat transfer. The arrangement finally accepted was a block of pure silver six by six inches and one inch thick. A fine thermocouple was embedded in the center of the surface facing the lamps. This was read out at a temperature recorder having satisfactory response time. The surface of the silver block was coated with a lacquer graphite mixture. A short heat run volatilized the lacquer leaving a very good heat absorbing surface. Fig. 2.

An adequate number of heat runs were made over the entire power range, plotting voltage and power input against temperature rise in the silver block. Various time rates of increase in power were tried. The resulting curves were examined for variations of rate and repeatability. The point at which the block began to lose heat out the back showed up clearly. Finally a steady and repeatable part of the straight line temperature rise was taken as reasonably indicating the BTU absorbtion in the block.

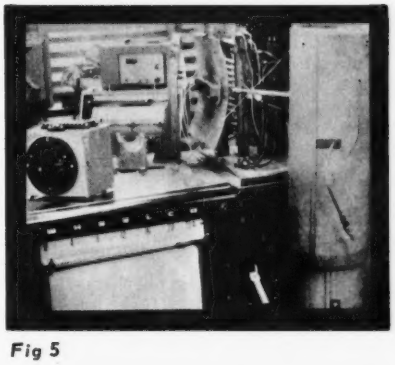


Fig 5

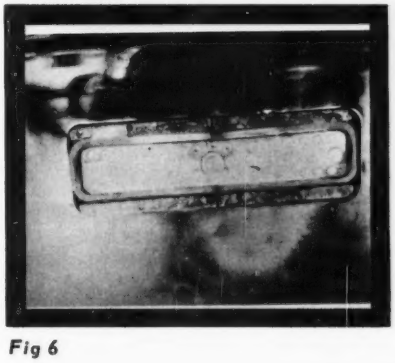


Fig 6

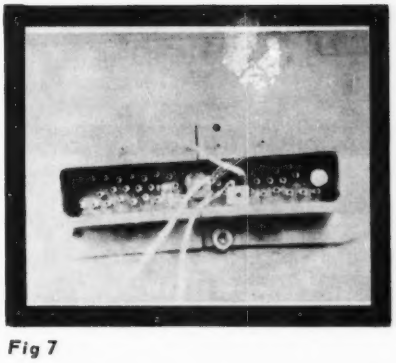


Fig 7

By formula, using temperature rise, area, time and the specific heat of silver, the BTU's per square foot per second was obtained. These values in terms of power or voltage input were used for constructing test curves to insert in the curve follower.

In actual testing of plugs some insulations gave out gasses and formed other byproducts of heating that would normally be removed in the case of a missile in flight. However in this test condition they sometimes deposited as a short circuit across the surface. Fig's. 6 & 7.

Therefore, an airblast arrangement was constructed to blow across immediately in front of the plug surface. This consisted of a sheet iron cylindrical tank about three feet long and ten inches in diameter. Inside was a bunched coil of quarter inch stainless steel much like a gas water heater. An air gas torch played on the coil from the bottom. The nozzle portion of the tubing leading to the specimen position was wound with a heating coil to prevent cooling at this point. The air temperature was controlled so as to avoid affecting the test. Fig. 5.

This apparatus affords a means of observing the effects of the absorbtion of large numbers of BTU's during very short periods of time. By the use of appropriate filters they may also be photographed. Some of the results are quite different from those obtained in ovens and markedly different from those obtained in the use of contaminating flames. It is an excellent test for warping and delamination. Heat transfer from the front to the rear surface can be recorded against time. Steady state values of BTU's can be used with accuracy. Various conditions of air blast can be used to observe removal of surface materials.

Briefly, Heat Flux testing furnishes an accurate means of studying the effects of radiant heat in terms of BTU's rather than conditions of degrees of temperature. A basic energy approach gives a clearer picture than working with dependent parameters.

LOW and HIGH TEMPERATURE ENVIRONMENTAL CHAMBERS

by Stuart Giles, Chief Engineer, Bemco, Inc.
North Hollywood, California

The race to outer space and the other planets is underway and the refrigeration, air conditioning and heating engineer is right in the middle of the struggle. In this case he is known as an environmental equipment designer and is called upon to design and fabricate devices which will produce, here on the ground, every predictable force which a space vehicle must withstand from manufacture through storage, launching and flight in the atmosphere and outer space. A flight of this sort will expose the vehicle to a temperature range of from absolute zero to many thousands of degrees as well as sound barrier pressures and absolute vacuums.

Although environmental equipment manufacturers are not, at the present state of the art, able to produce these ultimate conditions, we are rapidly approaching them and producing practical machinery which is not a mere laboratory gadget but a working tool for the people developing space travel equipment.

The term environmental engineering is nothing more than glamorizing the old battle of man against the elements. The greatest environmental engineers developed the use of fire and clothing to protect us against the cold. Comfort air conditioning is a refined form of the same thing. Environmental engineering usually implies very low and high temperature ranges and requires that close temperature control be maintained over a wide range. It is common to provide a -100 to +500 F temperature range within + or - 1 F. This is not too difficult a problem with cascade refrigeration systems, electric heat and air circulation. Unfortunately we must also simulate the outer space condition or near perfect vacuum and at the same time control remperatures. This is done by pure radiant heating and cooling as practically no air is present for conduction or convection. Temperature sensing elements must be mounted on or in the object tested and close control requires the most accurate potentiometer controllers with automatic reset and anticipators.

Altitude chamber temperature control has recently been under study by many groups. The advent of "space chambers" has created the realization that the inside surface temperature of the chamber creates the temperature environment of the test. The emissivity of this surface and the test package surface and their temperatures determine the heat transfer rate. This is because convection is non-existant and if the test package is properly suspended, conduction does not exist. Radiant heat transfer, therefore must be carefully controlled. Stainless steel vacuum chambers with emissivity of 0.90 to 0.93 and surface temperature control to + or - 2 F are now being manufactured. The most advanced chambers have as many as fourteen separately controlled radiant heating and cooling panels within the altitude chamber.

One successful method we have used to provide this closely controlled -100 to +500 degree range in a vacuum is to refrigerate and heat a fluid which is pumped through cold plate type walls lining the chamber. The fluid flow and temperature of the fluid can be modulated and temperatures held to very close limits much as in a panel heating system for buildings. Methal chloride is suitable for work to -130 F and various oils such as silicone and 150 bright stock are available for temperatures up to 550 F.

Cascade refrigeration systems using standard equipment are very practical for the -100 to -130 F temperatures. Freon 22 is used in the high stage and Freon 13 for the low. Freon 14 is now available in limited quantities for work down to -200 F. This means that a three compressor cascade system can be designed. Unfortunately there are many mechanical problems to be solved before a really satisfactory -200 F mechanical refrigeration system can be manufactured.

The relative advantages of liquid CO_2 and mechanical refrigeration are sometimes obscure. Other things being equal a rule of thumb is that if low temperature work is to be done more than 50 percent of the working days, mechanical refrigeration will pay for itself in one year because of lower operating costs. Liquid nitrogen has become readily available in most industrial areas. This provides an easily used expendable refrigerant for work down to -320 F. As a by-product of liquid oxygen, LN_2 may soon "take over" as the primary expendable refrigerant. It does not turn to "snow" when expanded as does LCO_2.

Very low temperatures can be produced and controlled by the use of liquid nitrogen (-320 F) and liquid helium (-452 F). These are commercially available and are practical refrigerants (although expensive). They are metered into an evaporator coil by a solenoid valve. Control at temperatures well above the boiling point of these fluids is difficult but may be accomplished by a carefully designed heating system. Take as an example the problem of controlling at -200 F when the refrigerant boils at -320 F. If close control is required a -100 heating fluid may be used to heat the space and compensate for the low-low temperature coil. Electrical heaters are frequently used but extreme care must be used to prevent overheating and arcing under vacuum and to provide satisfactory distribution of the heat around the devices being tested within the chamber.

Environmental chambers are constructed in almost any size from twelve inch cubes for small parts testing to 100 foot rooms for testing complete aeroplanes or missiles. The requirements of temperature and vacuum mentioned previously is only one of many. The so-called re-entry problem brings up the problems of high surface temperatures on the space vehicle. This is the point in the flight when the vehicle enters the earth's atmosphere from outer space at speeds of ten to twenty thousand miles per hour. The friction of the air will produce 2000 to 3000 F skin temperatures. Sputniks usually burn up. A ballistic missile or man carrying vehicle obviously cannot. Environmental chambers to simulate these conditions have been constructed using specially designed electrical heaters as a high temperature source.

Continued on page 30

RANDOM OUTPUT OF A COMPLEX MOTION SYSTEM WITH RANDOM INPUT

by H. BECKWITH

RAMO-WOOLDRIDGE CORP.

Data received from the flight test of missiles shows that the vibration environment is of a random nature. It is logical to believe that the degree of randomness may well vary from component to component, depending on the combined effects of the mounting and packaging. It is a difficult task to predict the actual vibrational environment a component will be subjected to even though the driving function to the package mounts can be described with a reasonable degree of accuracy.

Also the reliability engineer is further confronted with the problem of correlation between a sinusoidal driving function and a random driving function. It is not the intent of this paper to discuss this correlation, if the structure is such that a correlation does exist; but rather to discuss how a vibration exciter may be operated to give a desired random driving command. The testing engineer is interested in obtaining a correlation between a random vibration and a rms voltmeter reading. It is the intent of this paper to establish this correlation when a desired output is known.

The basic unit to be used in this discussion is the Power Density Spectrum. Actually, this parameter is a unit of energy contained in a given band; hence

$$\frac{(\text{volts})^2}{\text{cps}} \text{ or } \frac{(\text{g's})^2}{\text{cps}}$$

These units will be used throughout the discussion and some feeling as to their significance should be acquired. This discussion will not be concerned with deriving the density function from a given time function; rather how to obtain a desired density function after knowing the system parameters and the input driving function.

Military specifications state a constant value of g^2/cps vibration amplitude to a given frequency with a "roll-off" at a certain rate per octave. For instance:

$$\Phi_o(\omega) = \frac{K_1}{(jK_2\omega + 1)^2} \qquad (1)$$

where $\Phi_o(\omega)$ is the desired output spectral density function.

This particular function will give a "roll-off" of 12 db per octave.

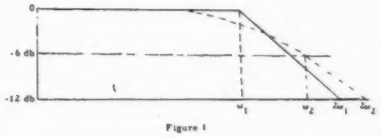


Figure 1

It can be seen that the stated function (solid line) may vary somewhat from the actual function (dotted line). Figure 1 is based on the usage of linear techniques to obtain the desired function. The stated function gives ω_1 as the critical frequency and $2\omega_1$ is one octave removed. ω_2 is the critical frequency using linear shaping methods with $2\omega_2$ being one octave removed. With this information, it appears possible to determine K_2 for any desired 6 db point. Actually, for a realistic condition, more consideration needs to be given to the average energy contained in the spectral density function. This will be examined later. The value of K_1 is specified in specifications and is the value of the function, $\Phi_o(\omega)$, as ω approaches zero. It is not feasible on most vibration exciters for ω to decrease below about 125 rad/sec. For random vibrations, the unit of K_1 will be g^2/cps and the units for K_2 will be seconds.

From the viewpoint of reliability testing it is desirable to consider the environment experienced by the package being tested. From the viewpoint of the test engineer it is desirable to consider the input and output of the test equipment. The difference between these viewpoints may be large or small, depending on the transfer function of the test equipment. It can be shown that:

$$\Phi_o(j\omega) = [G(j\omega)]^2 \, \Phi_{in}(j\omega) \qquad (2)$$

$\Phi_o(j\omega)$ = the output power density function

$G(j\omega)$ = transfer function of test equipment

$\Phi_{in}(j\omega)$ = input power density function

It must be remembered that all these quantities are also functions of ω

Special attention must be paid to G(jω). Figure 2 shows the known block diagram for a shaker system.

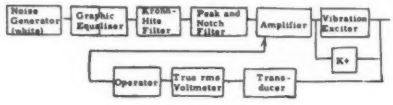


Figure 2

There are a number of variations the system may assume. The transducer, voltmeter, and operator are shown in the feedback loop. The accelerometer may be considered as frequency invariant; its transfer function equals a constant (K_o mv/g). The voltmeter and operator are considered to be frequency invariant in that they sense the change in envelope and not the individual frequencies. The shaker and amplifier will be considered frequency invariant for the time being, which focuses the attention on the filters* and on the graphic equalizer. These are the components which are primarily responsible for the output being as shown in Figure 1. Also, these components will contribute greatly to G(s) as shown in Equation (2).

The question now arises, what is the actual output with a known input? This is not an easy question to determine by mathematical methods.

$$\bar{e}_o^2 = \frac{1}{2\pi} \int_a^b \Phi_o(j\omega)\, d\omega \qquad (3)$$

From Equation (3)

$$\bar{e}^2 = \frac{1}{2\pi} \int_a^b [G(j\omega)]^2\, \Phi_{in}(j\omega)\, d\omega \qquad (4)$$

where $\bar{e}_o^2$ denotes the mean square energy contained in the frequency spectrum between a and b. It can be seen that uniqueness is not enjoyed; i.e., a variety of integrals can give the same value of $\bar{e}^2$. This integral may be evaluated several ways. Probably the most direct method is to plot the output as a function of ω and determine the area under the curve. Other methods are available; however, for this discussion, considering a finite integral, these methods do not contribute much to the results.*

It is known that the shaker response within the frequency band of interest is not flat. The system may be represented to the first order of approximation by: (5)

$$\frac{g}{\text{volt}} = \frac{K_o S(1+\tau_1 S)}{(1+A_2\rho_4 S+\rho_4^2 S^2)(1+A_3\rho_5 S+\rho_5^2 S^2)(1+A_4\rho_6 S)}$$

The transfer function is approximated from the frequency vs amplitude characteristic which has the following shape:

a. A peak (resonance) at approximately 200 cps.

b. A peak (resonance) at approximately 2100 cps.

c. Lim $\omega \longrightarrow \infty$ the output must equal zero.

d. The output is relatively constant between the peaks (200 and 2000 cps).

Figure 3 shows that the type of output to be expected from the exciter is not a smooth curve. The shaker has an internal closed loop.

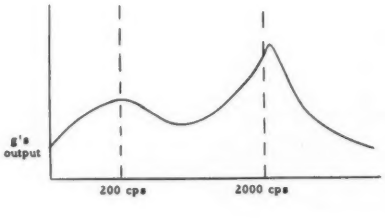


Figure 3

A survey of literature shows that for random excitation the peaks are compensated for by the peak and notch filters placed before the summing point which must have a transfer function that will compensate for the peaks and/or notches. (6)

$$\text{Peak and Notch Filter} = G_2(s) = \frac{K(1+A_2\rho_4 S+\rho_4^2 S^2)(1+A_3\rho_5 S+\rho_5^2 S^2)}{S(1+\tau_1 S)}$$

It must be remembered that these equations are approximations and no thought has been given to whether or not they are physically reliable. Also, the necessary circuitry may be quite complicated; it may be seen that Equation (6) is not physically reliable as stated because for any physical system

$$\text{Lim } G(s) = 0$$
$$s \longrightarrow \infty$$

This indicates the existence of another power of s in the denominator.

It should be apparent that the power density spectral output to the summing point must be as shown by Figure 4 which is the summation of the shaped spectrums. Each unit accomplished the following:

a. Graphic Equalizer
Determines the shape from 1000 cps to 2000 cps and the critical frequency.

b. Peak and Notch Filter
Compensates for inherent vibration exciter characteristics.

c. Krohn-Hite
Controls low frequency amplitude so shaker does not "bottom-out" thereby causing vibration transients and regulates the frequency response above 2000 cps (i.e., makes a multibrake above this value so that in the event any frequencies with large amplitudes above 2 kc are present, the the complete system will not respond).

The question arises, what does all the preceding mean? Considering

*The actual transfer function is where T_1 and T_2 can be adjusted. From Instructions Manual for Models 330A, Krohn-Hite Instrument Company

$$G_1(s) = \frac{NT_1^2 S^4}{(1+2AT_1 S+T_1^2 S^2)(1+2BT_2 S+T_2^2 S^2)}$$

*Theory of Servomechanism by James, Nichols and Phillips. Appendix, Table of Integrals.

the output of the noise generator white:

(7)

$$\Phi_o(j\omega)\ \frac{g^2}{(cps)} = \frac{1}{2\pi}\int_o^{2k} [G_1(j\omega)G_2(j\omega)G_3(j\omega)G_4(j\omega)]^2\ \Phi_{in}(j\omega)\ d\omega$$

$$G_1(s) = \frac{NS^4\ T_1^2}{(1 + 2AT_1S + T_1^2S^2)(1 + 2BT_2S + T_2^2S^2)} \quad \text{Krohn-Hite}$$

$$G_2(s) = \frac{(1 + A_3\rho_4S + \rho_4{}^2S^2)(1 + A_3\rho_5S + \rho_5{}^2S^2)}{S(1 + \ _1S)^2} \quad \text{Peak and Notch}$$

$$G_3(s) = \frac{1}{G_2(s)}\ \frac{K_o}{(1 + A_4\rho_6S)} \quad \text{Vibration Exciter}$$

$$G_4(s) = \frac{K_5}{(1 + \rho_7S)^n} \quad n = \text{positive integer} \quad \text{Graphic Equalizer}$$

For all practical applications $G_2(s)$ $G_3(s)$ equals one, which leaves the integral of $G_1(s)$ $G_4(s)$ ^{2} from zero to 2 kc to be evaluated. Due to the complexity of this evaluation, it is best to take the results obtained by graphic methods as an approximation. This approximation is valid as Figure 4 shows that the transfer function of the graphic equalizer is the controlling transfer function.

Now that the method for obtaining a desired power density spectral has been discussed, the question arises, what system adjustments are necesto deliver the desired function? The exact characteristics of the peak-notch filters will change with shaker load parameters and must be determined for each major configuration change in load. This can be accomplished by performing a sinusoidal sweep with constant input to determine resonance points. The setting of the Krohn-Hite Filter is determined by the over-all range of frequencies of interest. The writer has purposely restrained from calling this the bandwidth as this is not the bandwidth by definition. The main purpose of the graphic equalizers is shaping the spectral density within the limits established by the Krohn-Hite Filter. Figures 5, 6, and 7 show how this is done. For the first approximation of the error, the sum of the negative and positive areas can be made to vanish. From examining the figures, the actual bandwidth is limited by the half power point. This

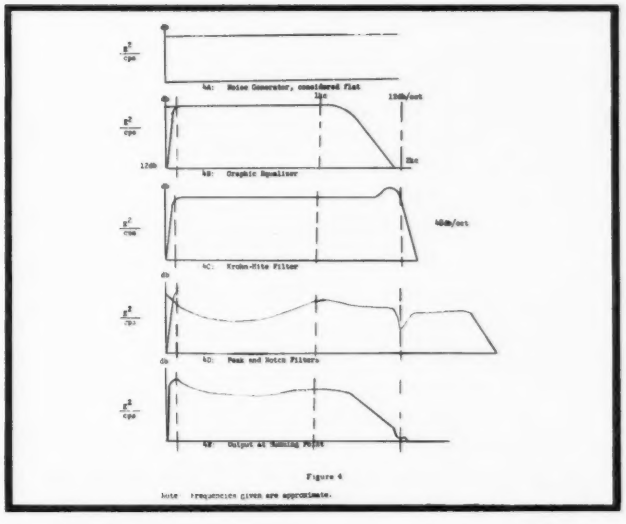


Fig 4

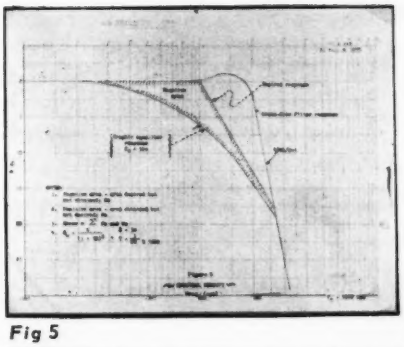


Fig 5

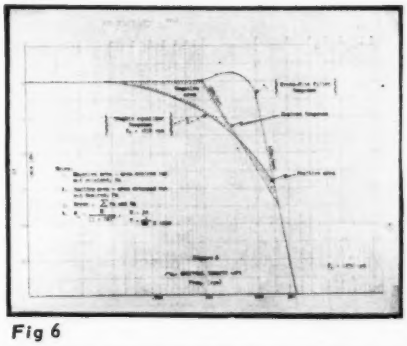


Fig 6

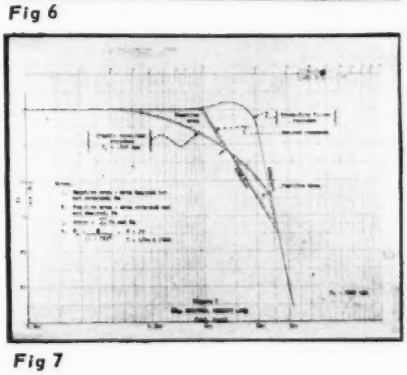


Fig 7

occurs at 6 db for a power function and at 3 db for a voltage function. Figure 5 shows the results of making the break frequency too small. Figure 7 shows that with the break frequency set at 1400 cps the positive and negative areas almost cancel. The curves presented are smooth theoretical curves; however, it must be realized that in practice peaks and notches may appear which would change the optimum value of fc, the graphic equalizer break frequency. Unless these excursions are great, an adjustment is not needed to stay within ±10 percent. Figure 8 shows the type of fitting obtained by using a double break filter in the graphic equalizer. This figure also shows very little improvement over the double break filter by a triple break filter. Actually, the double break filter gives improved results over the single break filter. The fc of the double filter will be approximately 2 kc. A better fit than shown by the attached figures can be obtained by crafty usage of nonlinear techniques; however, the complications involved are not justified.

The preceding discussion shows that unless some simple approximation can be accepted as valid, the task of evaluating the output spectral density will be a laborious chore. Fortunately, the approximation is given in terms of a definition.

$$g(rms) = \frac{1}{2\pi}\left[\int_a^b \Phi_o(\omega)\, d\omega\right]^{1/2} \quad (8)$$

This is the value of a true rms reading voltmeter will indicate. This implies that within fixed limits the g's rms are only a function of Φ_o; within probably ±10 percent. Hence, it can be stated that by shaping the input and by compensating for shaker response, a direct correlation exists between the system output (g^2/cps) and the rms voltmeter reading and that this correlation is unique. As previously stated, this integral can be evaluated by graphic means. The expression for the obtained spectral density is:

$$\Phi_o(s) = \frac{K_1}{(1 + K_2 S)^2} \quad (9)$$

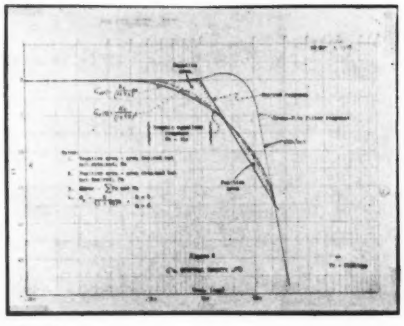


Fig 8

Since the adjustment shown by Figure 8 gives the closest approximation, this curve will be used to determine the g's rms. This is done by taking the average ordinate between f_1 and f_2 constituting Δf and is taken equal to 100 cps. The n = 4 curve is used:

$$\bar{g}^2 \text{ rms} = \Sigma \Delta f\left[K_1 + K_2 +++....K_{20}\right] \quad (10)$$

$$\bar{g}^2 \text{ rms} = 13.35\, K_1 \times 100 \quad (11)$$

$$g\text{'s rms} = 36.8\sqrt{K_1} \quad (12)$$

In the case of interest $K_1 = 0.2\, g^2/\text{cps}$

$$g\text{'s rms} = 36.8 \times \sqrt{0.2} = 36.8 \times 0.446 = 16.4 \text{ g's} \quad (13)$$

Unless system parameters are radically changed this gives a conversion factor from $\left[g^2/\text{cps}\right]^{1/2}$ to g's rms of 36.8.

In conclusion one may ascertain the following:

a. Reading the volts on an rms voltmeter corresponding to a specified g's rms is accurate enough for laboratory testing. The value of voltage is unique for a given adjusted spectrum.

b. The adjustment of the graphic equalizer is the major controlling factor. This adjustment may be a function of table loading.

c. Even though there are sophisticated methods for evaluating complex integrals, the graphic method gives results accurate enough for laboratory testing.

d. The accurate obtaining of a given spectral density function depends on how closely the peak and notch filters can be made to compensate for table load characteristics.

e. The Krohn-Hite Filter controls the over-all frequency parameters of interest.

f_1 to f_2 100 cps	Amplitude in % of K_1
0 - 1	1
1 - 2	1
2 - 3	1
3 - 4	1
4 - 5	.944
5 - 6	.87
6 - 7	.82
7 - 8	.75
8 - 9	.7
9 - 10	.68

f_1 to f_2 100 cps	Amplitude in % of K_1
10 - 11	.63
11 - 12	.575
12 - 13	.53
13 - 14	.5
14 - 15	.47
15 - 16	.44
16 - 17	.39
17 - 18	.376
18 - 19	.355
19 - 20	.316

NEW PRODUCTS

NEW HIGH-TEMPERATURE ISOMODE SHOCK AND VIBRATION ISOLATORS

NEW HAVEN, Conn. - A new line of Isomode shock and vibration isolators, for use at temperatures up to 500°F, is now available from MB Electronics, A Division of Textron Electronics, Inc.

These isolators are designed to provide shock and vibration protection at the higher temperatures encountered in high-performance aircraft and missiles. Vibration-sensitive airborne equipment such as radar antennae and associated electronic gear, for example, requires effective isolation from destructive high-frequency vibration.

These new isolators are capable of providing the desired performance when directly exposed to high temperatures. No external cooling is required. This design can restrict maximum resonant buildups in the low-frequency range to well below 3½ to 1 in any direction of vibration without sacrificing the high-frequency isolation efficiency. The units can be furnished with equal spring rates in all directions.

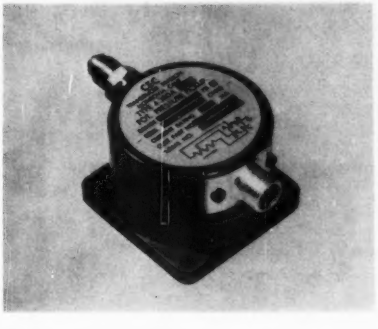
The new isomode mounts pass MIL-E-5272-A vibration and shock requirements, paragraph 4.7.1.2, paragraph 4.15.2.1, and paragraph 4.15.2.2. All metal parts are completely interlocked.

For further information write MB Electronics, Box 1825, New Haven 8, Conn.

NEW CEC POTENTIOMETER PRESSURE PICKUP

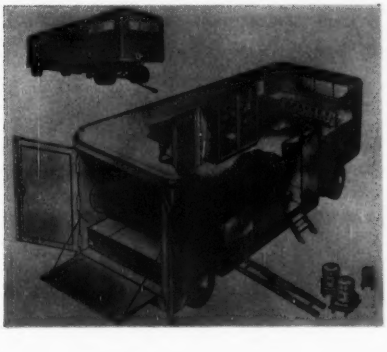
A potentiometer pressure pickup that will operate in such missile conditions as high-g acceleration and vibration for sustained periods has been developed by the Transducer Division of Consolidated Electrodynamics Corporation.

In an extensive testing program the 4-380A proved that it will withstand 100-g shock and static acceleration on three orthogonal axes without damage or unusual response. In addition, in answer to new requirements set down by missile manufacturers, the instrument is built to operate in vibration environments up to 25 g's for many hours, and throughout the frequency band to 3 kc. Operable temperature range is -65°F to 200°F. Maximum temperature is 300°F.



Differential, gage, and absolute models are available from 0-10 to 0-100 psi.

Normally, potentiometer pickups are used where voltage signals proportional to detected pressure are to be transmitted by telemetry or other means at a level sufficient to eliminate the need for amplification. But short life under extreme environments has been a drawback. This new instrument extends the conditions in which potentiometer pickups can be used.



NEW VIBRATION TESTMOBILE

NEW HAVEN, Conn.-A new vibration Testmobile unit, designed especially for ground flutter testing of aircraft and missiles, has been designed by Propulsion Test Facilities, Inc., affiliate of MB Manufacturing Company.

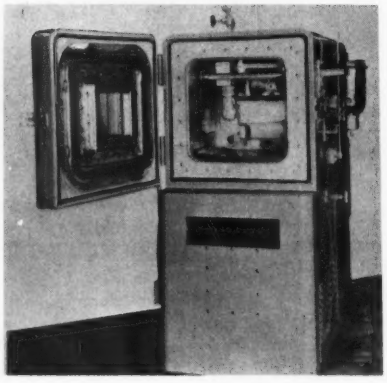
The basic unit consists of a weatherproof semi-trailer complete with vibration exciters, power supplies, and monitoring instrumentation for thorough analyses of structural vibrational modes. The system is engineered to provide maximum reliability, ease of maintenance, accessibility, convenience of operation, and attractive appearance. The trailer and equipment are designed for hauling on public highways by standard truck tractors, and for hauling at test locations by field tractors.

The Vibration Testmobile is designed to operate and control four vibration exciters simultaneously. However, due to the variation in force requirements for flutter tests on various aircraft and missiles, exciters having different force ratings are furnished. Six exciters are supplied with the basic unit: Four of these have a continuous rating of 0 to 150 lbs force vector; and two have a continuous rating of 0 to 25 lbs force vector.

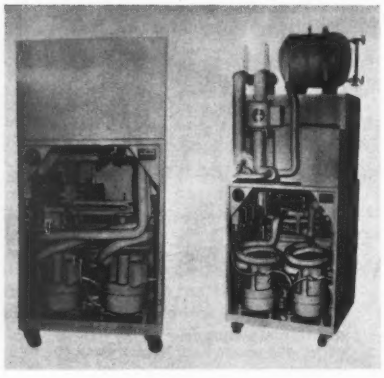
HIGH-LOW TEMPERATURE AND ALTITUDE CHAMBER FOR RADIATION TESTING

The first of an unique line of environmental chambers, that will test products and materials while undergoing radiation exposure, has recently been developed by Cincinnati Sub Zero Products, Cincinnati, Ohio.

The three cubic foot test chamber has an adjustable temperature range from +180°F to –80°F. Altitude can be controlled from sea level to 100,000 feet. This can be accomplished in fifteen minutes time. A steam vapor generator provides up to 100% Relative Humidity in the chamber. The water supply reservoir is mounted directly on the unit so that, except for the electrical service, it is completely portable on four 6" casters.



Radiation in the chamber is accomplished by a 1" diameter non-metallic tube that penetrates through the chamber and extends 6" on each side. A capsule of radioactive material is inserted in the tube for the test. The chamber can be used with or without the capsule in the tube.



PORTABLE PACKAGED REFRIGERATION

Portable, packaged, remote supplies of low temperatures to -120°F are provided with the utilization of a "Kold-Pak," a new line of refrigeration equipment by Tenney Engineering, Inc., Union, New Jersey.

The Kold-Pak is a one-piece, packaged, mechanical refrigeration assembly that provides low temperature mediums to any enclosure through heat exchangers that can be connected to the required flow lines. Kold-Paks are either of the direct expansion type, with freon refrigerants passing through a user's heat exchanger, or the brine chiller type with a liquid acting as a secondary cooling agent.

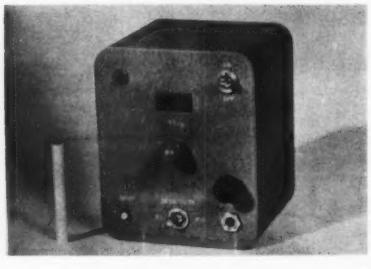
There are 12 standard models with the following capacity span:

At -40°F brine temperature or -60°F evaporator temperature, the capacity is from 3,240 to 34,000 BTU/hr. At -100°F brine temperature or -120°F evaporator temperature, capacity ranges from 660 to 7,000 BTU/hr.

Caster mounted for mobility, this economical source of low temperature makes it possible to refrigerate an independently built work space or to augment the capacity of other refrigeration equipment.

NEW VIBRATION INSTRUMENT

An accelerometer sensitivity standardizer called the DIAL-A-GAIN converts all accelerometer sensitivities to a convenient 1 Volt/g, allowing direct reading of acceleration on any VTVM. The DIAL-A-GAIN includes a cathode follower input and a precision amplifier with a continuously variable gain control dial, calibrated directly in accelerometer sensitivities.



Dialing the sensitivity of your accelerometer automatically adjusts the output to 1 Volt/g allowing direct reading of acceleration on any volt meter.

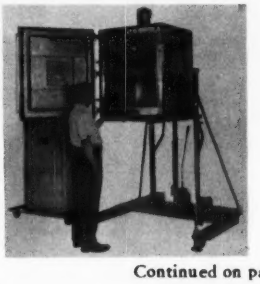
DIAL-A-GAIN eliminates external cathode followers normally used, and is available with single or multiple inputs.

For complete specifications, write Unholtz-Dickie Corporation, 2994 Whitney Avenue, Hamden 18, Conn.

NEW PRODUCTS RELEASE

Conrad portable temperature vibration chamber Model FBV-8. This chamber features a hydraulic lift for raising or lowering the chamber to accommodate a vibration exciter head through the bottom of the chamber or with an accessory adapter diaphragm through the side of the chamber. The temperature range is +800°F. to ambient temperature or with liquid CO_2 cooling to approximately -100° F. Instrumentation is available with several options from indicating controllers to strip chart potentiometer recording controllers. This chamber is designed to fit over a 5,000 pound force shaker. It can be used with other sizes also.

CONRAD INC.
CONRAD SQUARE, HOLLAND, MICH.



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ENGINEERED TESTING

ENVIRONMENTAL TESTING

Test equipment for the following environmental conditions is available in the laboratory as follows:

VIBRATION:	600# force; 2000 cps
ACCELERATION:	50# @ 50 g's
SHOCK:	Per Spec. 7201
TEMPERATURE: & HUMIDITY:	200°F 100% R. H.
TEMPERATURE: & ALTITUDE:	−100°F to +200°F 100,000 ft.
HIGH TEMP.:	To 1,000°F
RAIN:	4" per hour
SUNSHINE:	Per MIL-E-5272A
EXPLOSION:	Per MIL-E-5272A
FUNGUS:	Per MIL-E-5272A
SALT SPRAY:	Per MIL-E-5272A
SAND & DUST	Per MIL-E-5272A

All environmental equipment is suitably instrumented with recording, indicating and controlling devices and fully complies with the requirements of the Military Specification MIL-E-5272A.

FUNCTIONAL TESTING

Supplementing the normal services of an environmental test facility, Parameters, Inc. is also capable of functionally testing all components. Parameters, Inc. maintains a complete hydraulic, electronic and mechanical test facility to provide a 'one-stop' testing organization.

HYDRAULIC PUMPING UNITS

Flows to 100 gpm
Pressure to 5,000 psi dynamic
30,000 psi static
Fluids JP-4, JP-5, Varsol MIL-0-5606, OS45 MIL- -7808

PRIME MOVERS

Power from 1/20 to 160 HP; controlled variable speeds.

HYDRAULIC IMPULSE

Per MIL-5512-A

ELECTRICAL POWER

400 amp, 3 phase, 60 cps; 28 volts d-c; 400 cps.

INSTRUMENTATION – General electronic test equipment, including recorders, oscilloscopes, meters and oscillators. Transducers including flowmeters, pressure transducers, thermocouples and potentiometers.

SPECIAL EQUIPMENT – Specialized equipment for testing electro-hydraulic closed loop systems includes variable gain servo-amplifier, sine wave generator, phasemeter, servo valve and rotary and rectilinear potentiometers.

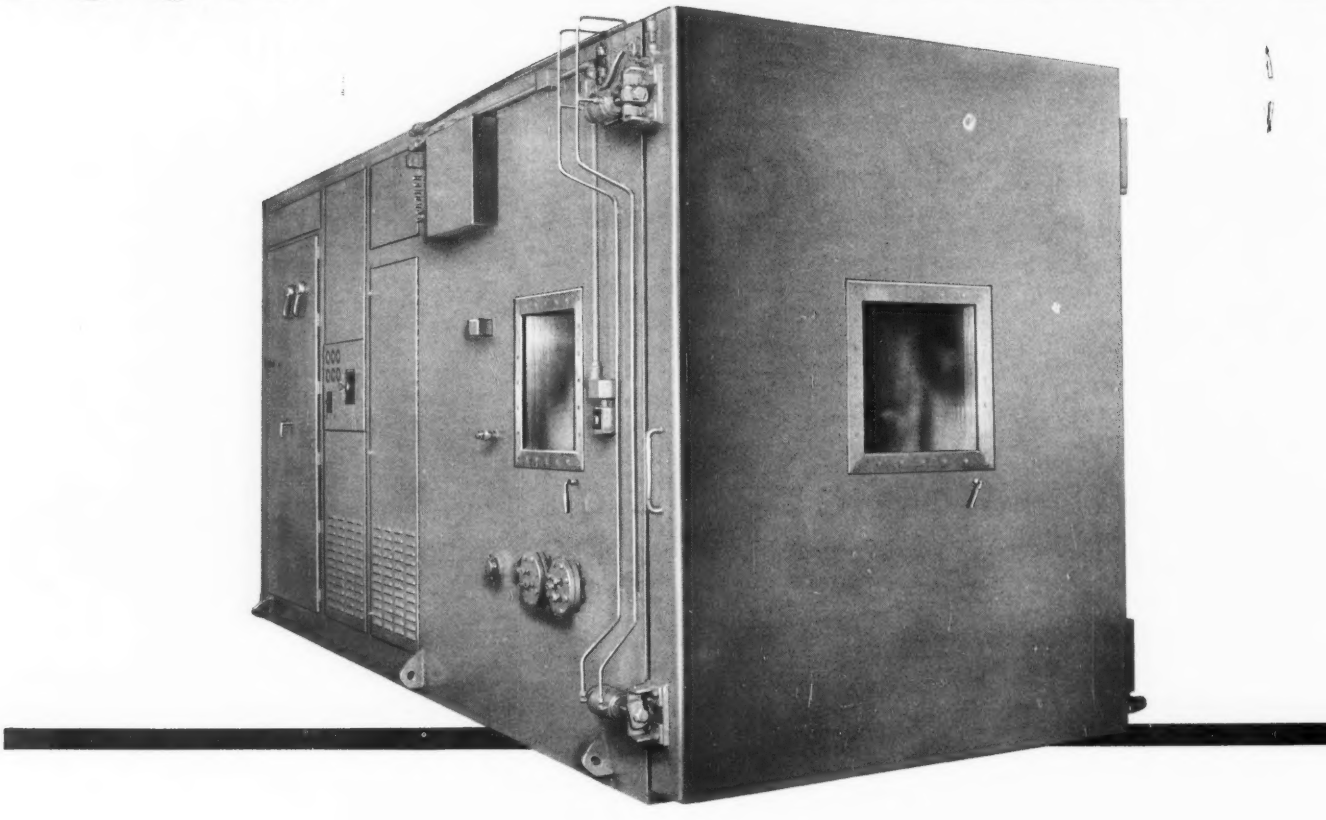
FOR MORE INFORMATION ABOUT THE TESTING, ENGINEERING, DESIGN OR DEVELOPMENT FUNCTIONS OF PARAMETERS, INC., WRITE TO:

PARAMETERS, inc.

195 HERRICKS ROAD
NEW HYDE PARK
NEW YORK

Pioneer 7-8484

100% automatically controlled CONRAD CHAMBER S



CONRAD Inc. MODEL WI 288-20-20

TEMPERATURE-HUMIDITY-ALTITUDE CHAMBER *with* CONSOLE

This chamber is supplied as a complete package unit, including all refrigeration, air supply, and vacuum system. It is designed to accommodate a large "shaker" for vibration testing of components in desired conditions of heat, cold, humidity, and altitude.

Size: 288 cu. ft.

Temperature Range: —100°F. to +500°F.

Humidity: 20% to 98%

Altitude: To 150,000 ft.

100% automatically programmed controlled.

Elaborate and versatile instrumentation of the Conrad chamber console includes running time meters, rate-timers, hold timers. Console has desk top, and storage space for test objects and special instruments.

D

R SPANS 0 TO 150,000 Ft. ALTITUDE

IN 10 MINUTES

Conrad engineers put this 288-cu. ft. chamber through strenuous paces in testing it for the customer. The precision of Conrad design and manufacture were clearly evident throughout, but particularly in the chamber evacuation test. Starting at ambient, the chamber simulated an altitude of 150,000 ft. in 10 minutes. This is performance. And performance is why the customer—a prominent aircraft and missile components manufacturer on the east coast—*again* specified Conrad in equipping their new research facility.

Conrad's experience and recommendations are always available to help you determine your environmental test chamber needs. Telephone or write the representative nearest you for prompt service.

Sales and Service Representatives throughout the U. S. and in Canada

KENT, CONNECTICUT
R. M. Alden
Box 278
Walker 7-3319

NEW YORK
R. M. Alden
21 Park Place
BArclay 7-7583

TORONTO, ONTARIO
Donald F. Beechey
1162 Main Street, N.
Toronto CHerry 4-8051

CHICAGO
William Mostrand
5111 West Diversey Street
MErrimac 7-3303

HOLLAND
M. Denver Armstrong

ST. LOUIS, MISSOURI
Warren Hull
828 Thornberry
TAylor 2-2241

ATLANTA
Ben T. Schladenhauffen
3230 Peachtree Road, N.E.
CEdar 3-5519

HUNTSVILLE, ALABAMA
Ben Schladenhauffen
Lew Wright
Donald R. Boyson
1404 Locust Avenue
JEfferson 6-9313

CLEARWATER, FLORIDA
W. Ben Wimberly
Robert F. Pond
532 S. Ft. Harrison Avenue
3-7072

PASADENA, CALIFORNIA
E. A. Wright
3848 E. Colorado Blvd.
MUrray 1-0181

DALLAS
W. N. Wright
5738 N. Central Expressway
TAylor 4-2571

HOUSTON
N. Gene Simpson
1803 Calumet Street
JAckson 3-5651

ORLANDO, FLORIDA
GArden 5-3083

SALT LAKE CITY-DENVER
Parrish Electronics
1804 S. St. Paul
Denver 10, Colo.
SKyline 6-9455

CONRAD Inc.

CONRAD, INC.
HOLLAND, MICHIGAN
A Subsidiary of Crampton Manufacturing Co., Grand Rapids, Michigan

flight testing on the ground

Environmental and Performance Testing for Quality Control, Reliability, and Qualification of Electrical, Electronic and Electro-Mechanical Components, Sub-Assemblies and Assemblies

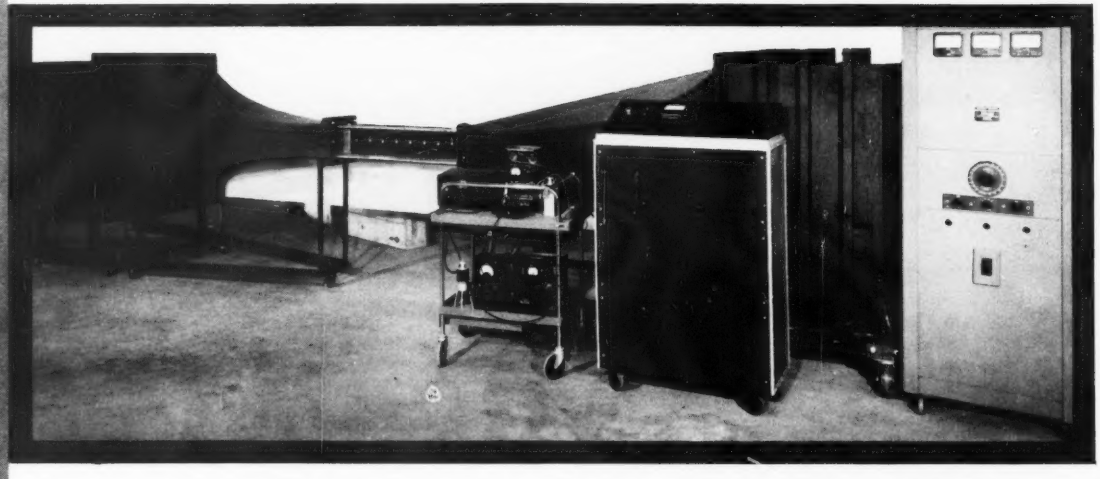
RANDOM NOISE ACOUSTICAL TESTING

Frequency spectrum: 75 cps to 10 K cps

Sound pressure level:

153 db (re: .0002 dynes/cm^2) in test chamber 5" x 5" x 16"
150 db in test chamber 8" x 8" x 40"
135 db in test chamber 40" x 40" x 40"

INTERMEDIATE SOUND PRESSURE LEVELS AND CHAMBER SIZES ALSO AVAILABLE



Acoustical vibration has recently been found--by the major airframe and missile manufacturers--to be an environment of prime importance in structures and electronic gear associated with jet and rocket engines. Rototest has developed and has operational a complete facility for testing components in high intensity sound vibration; much exceptional behavior has already been found in parts subjected to this environment.

Rototest is accepting requests for proposals to supply complete Acoustic Vibration test facilities.

ANOTHER ROTOTEST FIRST

CINE-RADIOGRAPHY: *Dynamic application of X-ray motion pictures to the study of behavior of electrical, electronic, electro-mechanical, hydraulic components, assemblies and sub-assemblies while under such environmental stresses as vibration and shock.*

rototest laboratories, inc. *2803 Los Flores Blvd., Lynwood, California*

I.E.S. NEWS LETTER

We wish to express our appreciation to all of the local chapters that are beginning to send in news of their chapters activities. To make sure your activities are published in the Journal, please forward through the chapter secretary all news items to I.E.S. Box 191, Mt. Prospect, Illinois, Attention Leon Carver with duplicates to the address of the Journal, Attention Charles Danielson. Items should be sent early in order to be included in the Feb., April, June, August, Etc. issues.

MID ATLANTIC CHAPTER

Chairman
Martin Schletter
Secretary
Daniel Grady

Meeting held on Oct. 7, 1959 in Glascow, Md. Mr. F. Klekotka, program chairman, presented Mr. J. Antolak who gave a talk on design considerations for environmental temperature chambers using liquid CO_2 as refrigerant.

NEW YORK METROPOLITAN CHAPTER

Chairman
Socrates N. Vavoudis
Secretary
Richard F. Hahn

Symposium and exhibition at the Henry Hudson hotel in Manhatten Dec. 10th and 11th. Theme at the meeting was "Instrumentation for the environments". Chapter address is Secretary, New York Metropolitan Chapter, Box 334 Upton Station, Hoboken, New Jersey.

The New York chapter is also printing a fine newsletter under the editorship of Raul Monzon. Address, P.O. Box 12, Pleasantville, New York.

BOSTON AREA CHAPTER

Chairman
Robert J. Graeff
Secretary
Alvie Jorgensen

NORTHERN CALIFORNIA CHAPTER

Secretary
Ray G. Danehy

We do not have complete information on this chapter as yet, however they did hold a meeting on Oct. 12, in Berkeley. Mr. Al Shapero of Stanford Research Institute gave a talk on the Weapons system analysis and integration model developed for WADC.

GREATER CHICAGO AREA CHAPTER

Chairman
Robert Jacobson
Secretary
Edgar Pauls

For membership write Steve Danko, Admiral Corp., 3800 W. Cortland Ave. Chicago, Illinois.

A meeting was held on Oct. 21, 1959 in Milwaukee, followed by a tour of the environmental facilities at A. C. Spark Plug Co.

DAYTON CHAPTER

Contact George Heck, Koehler Aircraft Products Co., 409 Leo St. Dayton 4, Ohio who is now Membership Chairman.

SAN DIEGO CHAPTER (PROPOSED)

Chairman
Bob Inabinette
Secretary
Jim Peterson

Their first meeting was on Nov. 4, 1959 in San Diego. A talk was given by Dr. Leslie Ball on "Environmental testing and its role in reliability."

SOUTHERN OHIO CHAPTER

Chairman
Donald J. Fox
Secretary
John L. Cahill

Donald J. Fox

John L. Cahill

Left to Right: Boggild, Schoenberger, Fox, Knief, Cahill

Last meeting in Columbus, Ohio on Dec. 9th, 1959. Several speakers gave talks related to Acoustic Problems of Flight Vehicle Design. The day session was followed by a tour of North American Aviation facilities in the evening.

LOS ANGELES CHAPTER

Chairman
Jerome Bakalish
Secretary
Orville G. Baer

Met on Dec. 7, 1959 in Los Angeles. The regular session was preceded by a meeting of the 1960 National Convention Board. Paul Elliot, program chairman introduced Burdell Kietzman, of Varian Assoc., who gave a talk on Production of High and Ultra High Vacumm with VacIon Pumps.

DETROIT CHAPTER

Chairman
Arthur B. Billet
National Director
Raymond G. Yaeger

SOUTHERN TIER CHAPTER

Chairman
W. G. Murray
Secretary
R. G. Meza

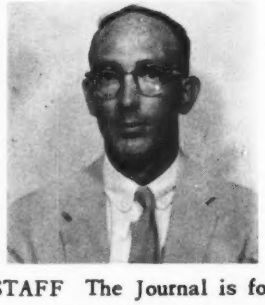
CHARLES W. DANIELSON TECHNICAL EDITOR

NOTES FROM THE EDITOR

At the December meeting of our National Executive board in Los Angeles, I had the opportunity to discuss various aspects of the Journal with several board members. Their helpful suggestions for enlarging and improving the Journal are outlined as follows.

PAPERS In the October issue I stressed the importance of original papers being submitted for publication and the service of the Journal in editing rough drafts. These should be sent to the Editor, 11916 West Washington Blvd. Los Angeles 66, Calif. or to Raymond Yaeger, Vice President Publications, Box 191, Mt. Prospect Illinois. Papers can be on any of the environments or instrumentation.

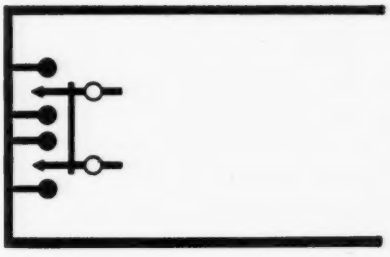
CONSULTANTS We wish to solicit the service of recognized authorities in any of the environments that would be interested in occasionally reviewing original papers for accuracy of content, published papers to include in bobliographies, other sources for papers on on the same subject.



STAFF The Journal is fortunate to now have the services of Robert Whiting as Associate Editor. Bob was formerly a member of the Los Angeles Chapters of IEE and SEE and has been active in the field of environmental engineering for several years. He will be soliciting, compiling and editing technical material for each issue. Any members in the local chapters that wish to offer their services may write the Editor.

I.E.S. NEWSLETTER In this issue we have news on the activities of several chapters throughout the United States. The local chapters can aid in publishing by forwarding their news through the chapter secretary to I.E.S., Box 191, Mt. Prospect, Illinois, Attention Leon Carver. Also forward a duplicate copy, particularly the chapter newsletter, to the office of the Journal. We will also try to fill any requests for additional copies of the Journal requested through the chapter secretary.

TECHNICAL INFORMATION



ARDC MODEL ATMOSPHERE CHART

Conrad, Inc., environmental test equipment manufacturer, has available for free distribution an "ARDC Model Atmosphere chart". The chart shows altitude in 1,000' increments to one million eight hundred thousand feet. It shows corresponding temperature in degrees F., pressure in millimeters of mercury, pressure in inches of mercury, and pressure in pounds per square inch. The chart also includes vacuum equivalents, microns to millimeters of mercury, and other factors, such as millimeters to dynes, inches of mercury to pounds per square inch, etc.

The chart is wallet size. It is of heavy base lacquered paper for permanence.

Conrad, Inc.
Conrad Square
Holland, Michigan

WIND TUNNEL TESTING

Instrumentation for acquiring and processing data from wind tunnel testing is described in an illustrated, four-page bulletin offered by Consolidated Systems Corporation, a subsidiary of Consolidated Electrodynamics.

Details of the system, components and operation are included. An actual instrumentation of a high-speed wind tunnel is described. Bulletin 3020 is available from:

Consolidated Systems Corporation
360 Sierra Madre Villa,
Pasadena, California

CARBON DIOXIDE ENVIRONMENTAL TESTING

Pure Carbonic Company has just issued a six-page, two-color brochure on the uses of carbon dioxide (CO_2) for low temperature environmental testing.

The brochure describes, with photographs and easily followed diagrams, the four principal methods used in industry today: direct injection of CO_2 bulk liquid; use of syphon cylinders or "Dry-Ice" Liquidors; direct cooling with "Dry-Ice"; and the use of CO_2 liquid or "Dry-Ice" to chill a low-freezing circulating fluid.

For your copy write:

Pure Carbonic Company, a division of Air Reduction Company, Inc.,
150 East 42nd Street
New York 17, New York.

Specify form ADPC 44.

HARRIS TEMPERATURE-HUMIDITY CHAMBERS

A new 2-color catalog folder by Harris Refrigeration Co., Cambridge, Mass., illustrates and describes their new series of temperature and humidity chambers, ranging from a compact 2 cu. ft. portable unit for small requirements up to a 10 cu. ft. production testing model.

Copies of the new catalog folder on environmental testing equipment may be secured at no charge by writing:

Harris Refrigeration Co.,
308 River St.,
Cambridge 39, Mass.

PRESSURE PICKUP

Consolidated's new 4-380A Potentiometer Pressure Pickup for missile use is described in an illustrated bulletin offered by the Transducer Division of Consolidated Electrodynamics Corporation.

The pickup is designed to operate accurately and reliably in rugged environments. A general description, design features, and specifications are included in Bulletin 1604, available from:

Consolidated Electrodynamics Corporation.
360 Sierra Madre Villa,
Pasadena, California

ENDEVCO QUARTERLY

The fall 1959 issue of The Endevco Quarterly is now out. This issue describes the Ford vibration instrumentation, a new low impedance all-transistorized "charge" amplifier, the new 2215 Endevco accelerometer, humidity and standard Endevco accelerometers and accelerometer mounting studs among other subjects.

Write:

P. L. Shugart, Editor
161 East California Blvd.
Pasadena, California

NEW SHOCK TESTER FOR PRODUCTION APPLICATION

The Rochester Division of Consolidated Electrodynamics Corporation announces a new bulletin (No. 4-71) describing the HY-6500 Shock Tester.

Continued on page 28

SPS

S - The MANUAL of test procedures
P - The ENCYCLOPEDIA of test information
S - The DICTIONARY of test interpretation
For Engineers, Technicians, Management

A LIBRARY OF TESTING INFORMATION

The System of Procedure Specifications provides test procedures covering requirements of Military Specifications such as MIL-E-5272, MIL-E-4970, MIL-STD-202 and collected procedures covering particular environmental testing such as vibration, shock, climatic, etc. Each SPS is handsomely bound and available on a subscription basis. The subscription carries one year's free service which will include revisions to keep pace with all military specifications.

The large number of major industries that are now subscribers to SPS are rapidly making SPS the industry recognized standard of test information.

Phone or write for a demonstration at your plant. System of Procedure Specifications, 11916 W. Washington Blvd., Los Angeles 66, California. Phone UPTON 0-6821.

Continued from page 27

The HY-6500 is designed to produce in rapid succession either of two waveforms frequently encountered in volume production: the half-sine pulse and the sawtooth pulse.

For further information, write for Bulletin 4-71 to:

Consolidated Electrodynamics Corporation
1775 Mount Read Blvd.
Rochester 3, New York

VTR NEWS

Volume 2 Number 2 of the VTR News is now out featuring information on bulletins available for digital displays, portable recorders, direct-reading solid state counters, transient free high-current power supplies, light weight recorders, and new, small power supplies as well as other technical information.

For your copy, write to:

V. T. Rupp Co.
307 Parkman Avenue,
Los Angeles 26, California

HIGH VACUUM VALVES, BAFFLES AND TRAPS

Consolidated Electrodynamics announces a new bulletin (No. 10-1) describing in detail valves, baffles traps now available for high vacuum work.

For further information write for Bulletin No. 10-1 to:

Consolidated Electrodynamics Corporation
1775 Mount Read Blvd.,
Rochester 3, New York

INSTRUMENTATION

Minneapolis-Honeywell announces that the September-October 1959 issue of Instrumentation is now available.

Write:
J. W. Sullivan, Editor
Minneapolis-Honeywell Regulator Company
Industrial Division
Philadelphia 44, Pa.

COMING EVENTS

Jan 11-13 - Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D.C.

Feb 1-4 - Winter Conference & Exhibit Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston, Texas

Feb 3-5 - Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles, California

Feb 16-18 - First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Texas. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Mar 23-25 - Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Company; National Science Foundation.

Apr 6-8 - National Meeting "Hyper-Environments-Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, California.

Apr 27-28 - National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 10-12 - Electronic Components Conference, Willard Hotel, Washington, D.C. Sponsors: Institute of Radio Engineers' Professional Group on Component Parts; American Institute of Electrical Engineers; Electronic Industries Assn.; Western Electronic Manufacturers Assn.

NEW FACILITIES

CALDWELL, NEW JERSEY OCTOBER 21, 1959

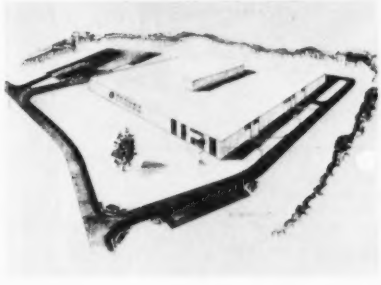
A new major environmental testing facility to be located in Orlando, Florida, is planned by Associated Testing Laboratories, Inc.

The new plant will be equipped with a complete range of advanced testing devices for environmental, qualification and reliability testing of all types of aircraft and missile components and systems.

Bernard Novak, company vice president, said, "You might term this new facility a space reliability center for the products of Southern missile and electronics companies. Here we will simulate actual conditions of temperature, vibration, shock, acoustic noise, humidity, altitude, and other environmental and operating effects to which highly sophisticated missile equipment is subjected in flight."

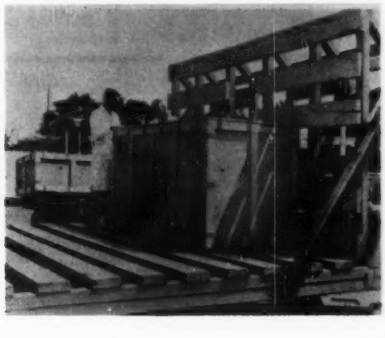
JOHN E. SCHMITZ NAMED G-M AND CHIEF ENGINEER AT E, P & D NEW CHEMICAL DIVISION PLANT

John E. Schmitz, former Research Engineer with North American's Autonetics Division, specializing in research and development in the Engineering test laboratories, has been appointed General Manager and Chief Engineer of the recently formed Chemical Division, Electronic Production & Development, Inc., 501 North Prairie Ave., Hawthorne, California.



NEW TENNEY ENGINEERING PLANT FOR HEAT TRANSFER COMPONENTS NEARS COMPLETION AT WILMINGTON, N. C.

WILMINGTON, N.C. -A completely new plant is nearing completion here for the heat transfer division of Tenney Engineering, Inc., leading manufacturer of environmental test chambers and heating, air conditioning and refrigeration components.



FULLERTON, CALIFORNIA

Following the business trend that relates the importance of the package with the product, AMERICAN LABORATORIES, The largest independent environmental and reliability product testing facility in Western United States, is now accepting packaging and materials handling test work.

ENVIRONMENTAL TEST FACILITIES AT TDI

The complete environmental test facilities located at the Tele-Dynamics, Inc. plant in Philadelphia are covered in Bulletin 859. Charts and tables list equipment capabilities while photographs show the equipment in operation in the laboratory.

Copies of Bulletin 849 are available from Tele-Dynamics, Inc., 5000 Parkside Avenue, Philadelphia 31, Pennsylvania.

NEW V.E.C. CANADIAN PLANT

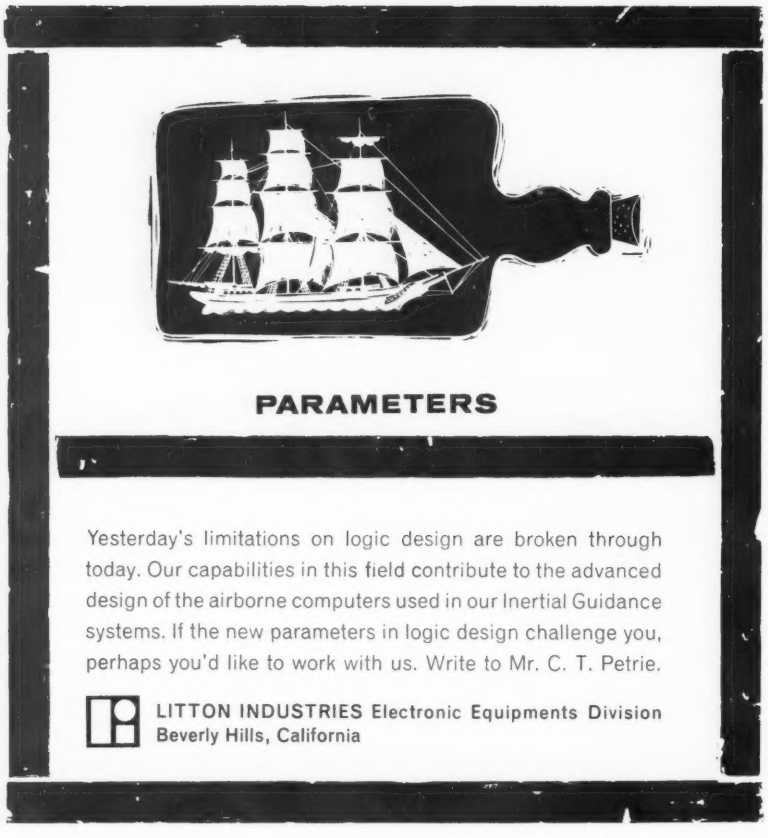
United Electric Controls Co., Watertown, Mass., manufacturers of temperature, pressure and vacuum controls, has announced the establishment of a manufacturing facility in Canada. The new firm, whose name is Electric Controls (Canada) Ltd. is located in Dorval, Quebec. Mr. Lorne J. Inglis has been appointed General Manager.

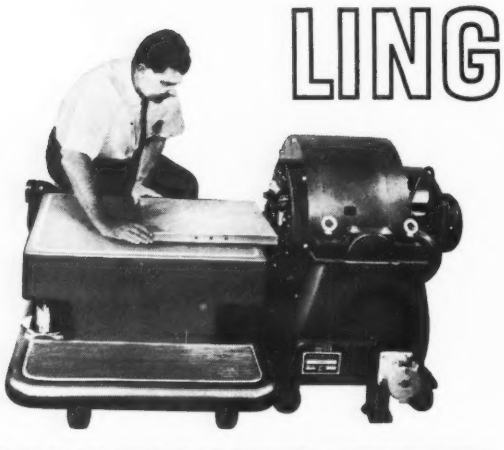
For further information, including new literature describing the products of the new company, write Lorne J. Inglis, United Electric Controls (Canada) Ltd., O'Connell Ave., Dorval, Quebec, Canada.

CALIBRATION OF ELECTRICAL, ELECTRONIC, MECHANICAL STANDARDS OFFERED BY UNITED STATES TESTING COMPANY

Because of increased activity by various Government agencies in verifying that test equipment calibration meets Bureau of Standards reference Standards, United States Testing Company, Inc., Hoboken, N.J., is now offering a complete service package which will meet all existing Governmental requirements.

This new service is applicable to all measured standards affected by Governmental contracts, including current, voltage, resistance, inductance, capacitance, frequency, temperature, and the like.


PARAMETERS
Yesterday's limitations on logic design are broken through today. Our capabilities in this field contribute to the advanced design of the airborne computers used in our Inertial Guidance systems. If the new parameters in logic design challenge you, perhaps you'd like to work with us. Write to Mr. C. T. Petrie.
LITTON INDUSTRIES Electronic Equipments Division
Beverly Hills, California



SIMPLE WAY TO INCREASE SHAKER PERFORMANCE!

This Ling "slippery" table—a new vibration accessory—can improve performance of almost any shaker.

Shown here with a Ling Model A-174 Shaker, the Ling Slip Table simplifies fixture and specimen mounting—saves time and tooling costs—and permits full stroke of shaker because all weight is removed from shaker head.

Write for Ling Bulletin WM-120. Ling Electronics, Inc., 9937 West Jefferson Boulevard, Culver City, California.

Continued from page 12

The most recent inovation in environmental chamber requirements is for separate temperature control systems for the different sides of the chamber. This is to simulate the condition in space of high intensity sunshine on one side of the vehicle while the opposite side is radiating to the black sky which is equivalent to an absolute zero black surface. Such an environment produces severe stresses within the structure of the vehicle. (Not to mention the stresses within the environmental chamber.)

Controlled humidity chambers are another interesting environmental problem. Both wet and dry bulb temperatures must be controlled between 35 and 200 F holding humidity within 2 - 5%. This requires wet bulb depression control + or - 1 F or less in certain ranges. This control tolerance is not only required under steady state conditions but during changes in temperature as well.

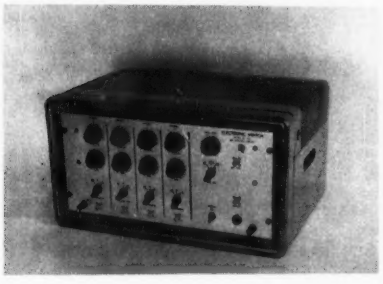
Cam programmers are used to reset the wet and dry bulb temperatures automatically. Humidification in the lower temperature range is accomplished by the use of steam. Automatic switch-over from steam to water and back again is required. Dehumidification is by a refrifrigeration and reheat cycle.

Control instruments should be the electronic type using a thermocouple for the sensing element to avoid the lag problem inherent in a gas or liquid filled thermal instrument. Adequate air circulation within the controlled space and across the wet bulb must be provided. Maintaining very low relative humidities is sometimes a problem in small chambers because of evaporation from the wet bulb wick. This is another reason for using thermocouple sensing elements which allow the use of small wicks and provide minimum evaporating surface.

Design of systems providing accurate control of temperatures over a wide range requires the best instrumentation available, automatic modulation of capacity, thorough understanding of heating and refrigeration principles plus a lot of horse sense. Compromising on any of these requirements produces equipment which will fall far short of the desired results.

The art of designing and manufacturing environmental chambers is moving ahead very rapidly. A few years ago a -100 F to +300 F altitude chamber to 150,000 feet was considered sophisticated. Today we are producing chambers with close control down to -320 F and up to 2000 F and vacuums in the 10^{-6} mm Hg. range. Neat year? - - - - who knows.

Continued from page 18



ELECTRONIC SWITCH

The Newton ES-142 Electronic Switch accepts four independent signals and sequentially connects them to a single output for a four trace display on a single channel oscilloscope. Its self-contained, regulated power supply requires 115 volts, 60 cycle current at 3 amperes.

Standard sampling rate is up to 100 KC, permitting 10 micro-seconds per position.

The counter provides its code to the diode matrix which also is receiving input signals. As the counter cycles, it sequentially connects each input channel to the output. The entire switch is direct coupled and contains provision for DC level shifting so that the levels of the incoming signals are added to the internal level producing the desired output DC levels.

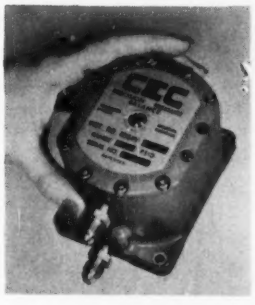
The unit is easily checked for individual channel calibration by connecting the four inputs together and superimposing the four signals, resulting in one waveform.

KENNEMATT CO.
VAN NUYS, CALIF.

MINIATURE PRESSURE BALANCE

The Transducer Division of Consolidated Electrodynamics Corp., Monrovia, Calif., has introduced a substantially smaller and lighter Precision Pressure Balance for use with its Electromanometer precision pressure measuring system.

The transducer portion of the system has been reduced in size from a cylinder 5-1/4 inches in diameter and 6-3/8 inches high, to a compact aluminum case measuring only 4 x 3 x 2-1/2 inches. Weight



was reduced from 10.7 to 2.6 pounds.

Seven pressure ranges are available from 0 - 1-1/2 to 0 - 150 psi differential. Output of the transducer is ±100 volts full scale. Combined effects of linearity and hysteresis are less than .05%.

Because of the high output of the transducer and its almost infinite resolution, the transducer can be downranged to 10% of its rated pressure without loss of accuracy and still provide ±10 volts at this suppressed range.

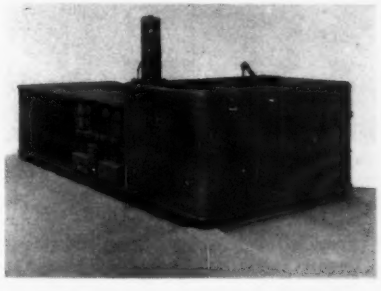
REFRIGERATION EQUIPMENT FOR PRODUCTION CHILLING

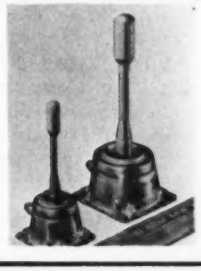
Sub Zero Products, Cincinnati, Ohio, announces a special low temperature production chilling machine, Model 7SR-120-32, designed for stabilization of metal aircraft structures.

The chamber has a maximum low temperature of -150°F and a thermal capacity of 14,000 BTU/hr at -120°F. With the pre-chilled liquid in the chamber 500 pounds of steel per hour can be chilled from ambient temperature to -110°F.

Over-all dimensions of the machine are 140" Long, 66" Wide, 38" High. The zinc coated, liquid-tight chamber measures 60" Long, 36" Wide and 26" Deep.

For further information on low temperature chambers for environmental testing or production chilling, write to Cincinnati Sub Zero Products, 3932 Reading Road, Cincinnati 29, Ohio.





HIGH-INTENSITY MICROPHONES FOR ADVERSE ENVIRONMENTS

Two new High-Intensity Microphones NM 125 and NM 135 have been released by B & K Instruments, Inc., 3044 West 106th Street, Cleveland 11, Ohio. Both microphones use self-generating ceramic sensors with an operating temperature range of -60° C. to +260° C.

The linear dynamic measurement range is 95 db to 200 db. Isolation mounts effect a low sensitivity to vibration and shock. Humidity, temperature shock and rapid atmospheric pressure have a negligible effect on the microphone operation.

The two models accommodate different requirements for frequency response and size. For detailed information request technical brochure CI-NM 135.

NEW LOW-COST ENVIRONMENTAL TEST CHAMBERS ANNOUNCED BY INTERNATIONAL RADIANT CORP.

New from the International Radiant Corporation, manufacturers of Environmental Test Equipment, of 577 East 156th St., New York 55, New York, is its ValuLine, a series of low-cost environmental test chambers.

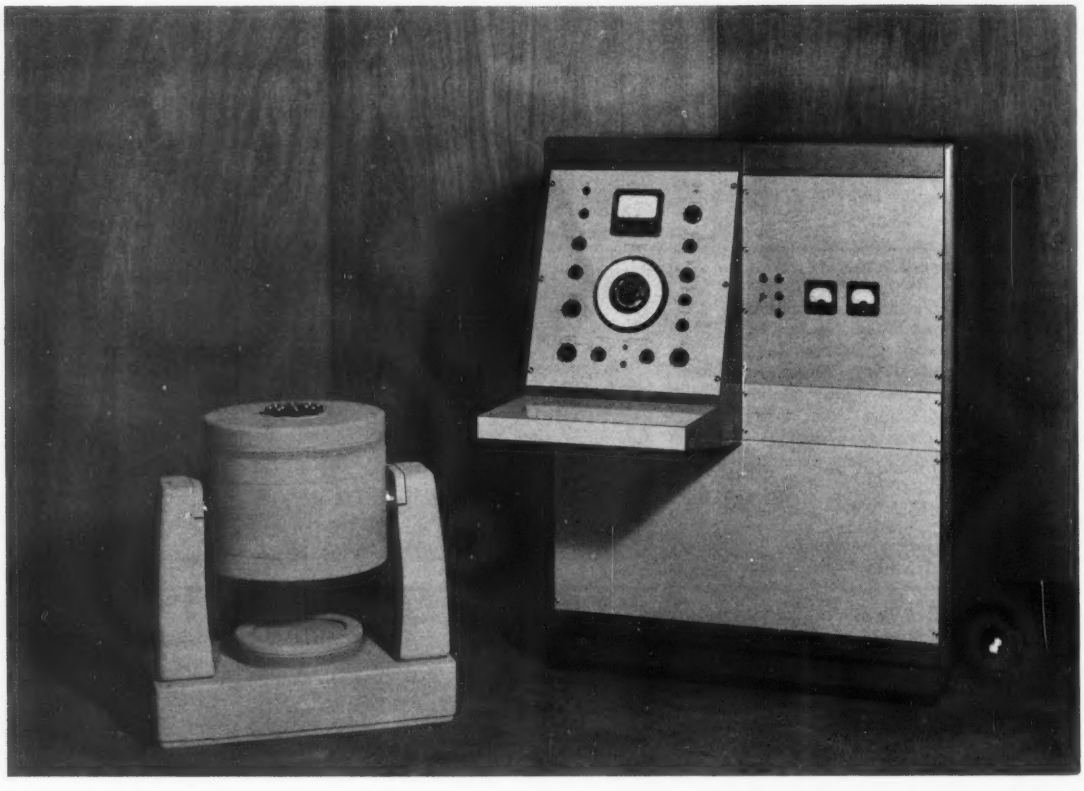
The vanguard of the ValuLine series is the ValuMite, designed specifically to meet low and high temperature testing

needs of the missile component field. It has been designed for bench mounting. The ValuMite features 2 cubic feet of stainless steel test space.

The ValuMite incorporates a mechanical refrigeration system to cool to minus 100 degrees F., and is electrically heated to plus 250 degrees F.

It features precision temperature control with a 1 degree C., temperature tolerance.

Unified Vibration Systems



The most complete vibration test systems in their size range. The shaker, amplifier, controls and accessory group have been engineered for unified performance. Advanced component design and ideal matching of individual units result in the maximum vibration environment at lowest system cost. This series features versatility, ease of operation, precision control of vibration levels, interlocks and safety devices to protect personnel and equipment; making the system suitable for unattended endurance testing.

SYSTEM FEATURES

100 to 350 pounds force
5 to 10,000 c.p.s. frequency range
5 to 5,000 c.p.s. Automatic cycling continuous sweep without switching
Regulation and visual monitoring of acceleration and displacement
Controls from accelerometer or Velocity Pickup
Direct reading Vibration Meter
Convenient Console
Dial-A-Gain for adapting accelerometers of various sensitivities
Low voltage amplifier
Adjustable field supply
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Adjustable sweep frequency limits

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Exciter features a light moving element with high natural frequency. Double end magnet construction provides maximum field to reduce amplifier requirements with very low flux density at the table. The Unholtz-Dickie rectilinear suspension allows 1 inch table travel without flexure resonance distortion in table waveform, while providing maximum lateral and rotational stiffness. Closed table top and hood reduce possibility of foreign objects entering machine. Rugged construction and heavy cast base with large safety factors avoid handling and fatigue damage.

EXCITER FEATURES

Axial resonance over 5,000 c.p.s.
1" stroke Unholtz-Dickie rectilinear suspension
Double end magnet structure
Low stray field at table
Convenient bolt pattern
Removable table inserts
Accelerometer under center insert
Air and fluid cooling
Blower mounted in base
110V convenience outlets on base
Overtravel and thermal protection

UNHOLTZ-DICKIE CORPORATION

EXPLOSIVE HAZARD CHAMBERS

BEMCO

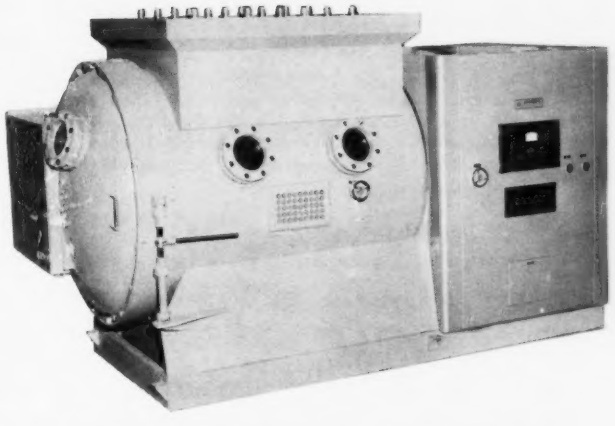
Environmental tests must frequently be conducted under conditions which may induce explosions or fires. High temperature tests of hydraulic fluids, tests of pressure vessels, fuse and igniter evaluation and similar work requires specially designed environmental chambers.

Protection of personnel, the chamber and the surrounding facilities require "special" design features in this type of environmental facility. Performance available covers the complete range of altitude, temperature, humidity, etc. as indicated in the other sections of the Bemco catalogue.

Bemco X-chambers combine special structural design features with automatic safety instrumentation for safe, easily operated equipment.

The following items should be considered when specifying chambers of this type:

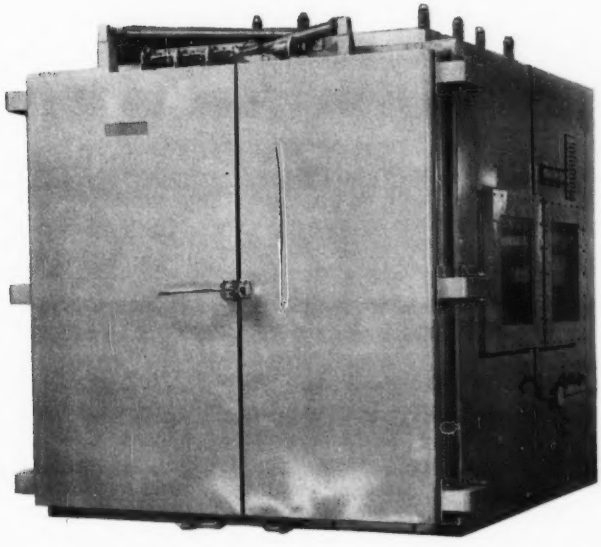
1. Size of test space. The volume displaced by the test item should be less than 50% of the internal chamber volume.
2. Pressure release devices which prevent the internal pressure from building up to a dangerous level. One square foot of vent area to each fifteen cubic foot of volume is considered optimum for explosive gas filled chambers.



A typical high altitude, high pressure explosive hazard chamber with diffusion pumping systems to 1 x 10^{-4} mm Hg. and a 150 psi pressure vessel. The explosion relief ports are in the top. A quick opening door, electrical feed throughs and bullet resistant windows are also shown.

3. Explosion resistant windows and lighting for observing the equipment under test.
4. Accessories, as required, such as cable ports, operating rods, thermocouple terminals, electrical connectors, and similar aids to testing.
5. Instrumentation to read and control temperature, pressure, vacuum, and other environmental conditions within the chamber.
6. Gas analysers for checking and warning, O_2 content, CO_2 content or other critical chemical components within the chamber.
7. Safety instrumentation such as flame detectors, high temperature alarms and fire extinguishers.

Chambers for explosive hazard work are constructed in tank or rectangular configuration dependent upon test requirements. A-Series, F-Series and W-Series Fly Sheet data applies to these types for vacuum, temperature and humidity performance and accessories. Construction is usually stainless steel inside and mild steel exterior.



A typical walk-in chamber with explosion relief hatches in the roof, shatterproof windows, automatic flame detector, oxygen analyser, CO_2 fire extinguishing system, and other accessories for complete safety while testing hydraulic devices above the flash point of the oil. The remote instrument panel is not shown.

Bemco Inc. develops, designs and manufactures a complete line of environmental equipment for simulating altitude, vacuum, pressure, temperature, humidity, salt spray, sand and dust, sunshine, rain, explosion and other conditions. Further details will be sent on request.

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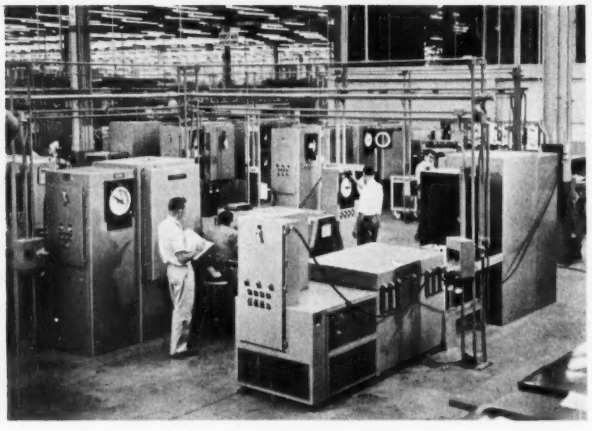

Twelve Missimers Chambers in Convair's huge laboratory include thermal shock, high and low temperature testing and humidity cycling.

Convair / Pomona Chooses Missimers

for "control accuracy, repeatability and ease of operation"

Reliability specifications of purchased electronic parts are determined through an unusually comprehensive program at Convair/Pomona, Convair Division of General Dynamics Corporation.

Called the "Quality Assurance Environmental Test" program, it was established primarily to make certain that environmental conditions specified could be met through successive lot deliveries.

Within a modern lab, twelve Missimers Chambers provide thermal shock, high and low temperature cycling and programmed humidity tests. These quality Missimers Chambers must meet particularly tough specifications of control accuracy, repeatability and ease of operation in order to make such a continuous program practical.

A complete line of Missimers Chambers is available for temperature, humidity, explosion, sand and dust and altitude testing in sizes and capacities to suit your requirements. Call or write for information.

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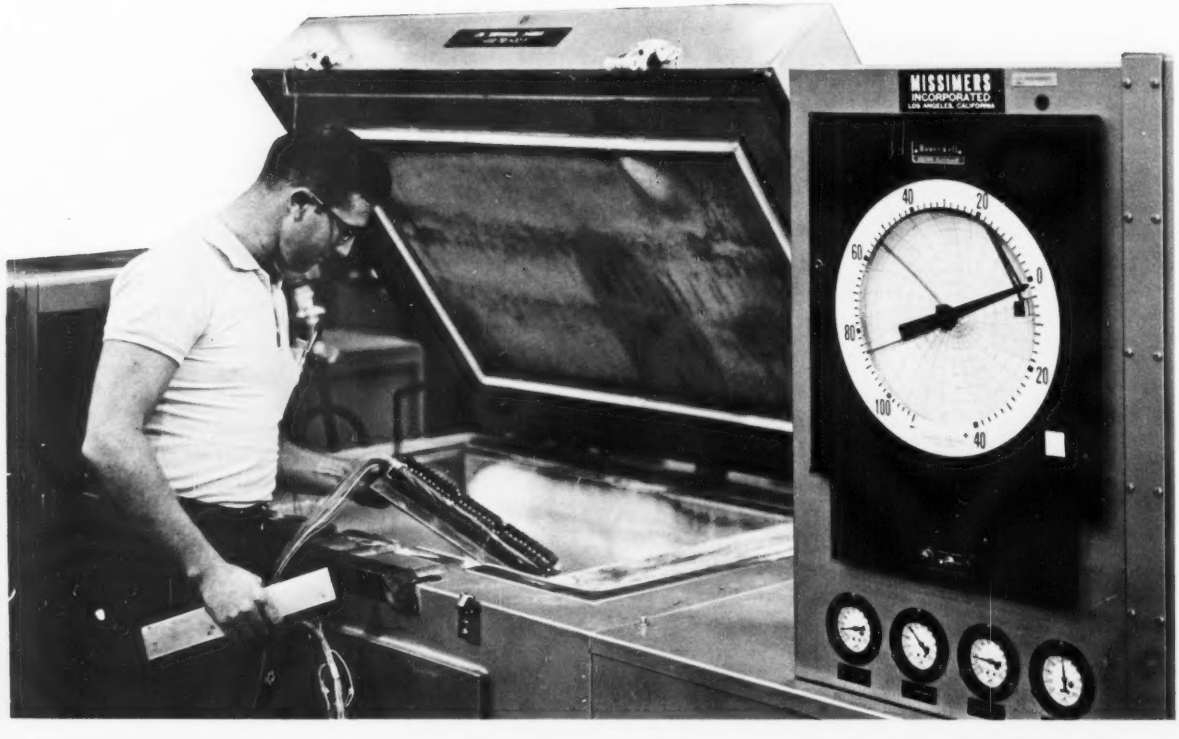

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TEMPERATURE ALTITUDE HUMIDITY CHAMBER

- **Temperature Range** —120°F to +500°F
- **Altitude Range** Sea level to 200,000 feet
- **Humidity Range** 20% to 95% between +35°F and +200°F, limited by a low dewpoint of +35°F.

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- Electric Feed-Thru Terminals
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- Casters
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ALTITUDE
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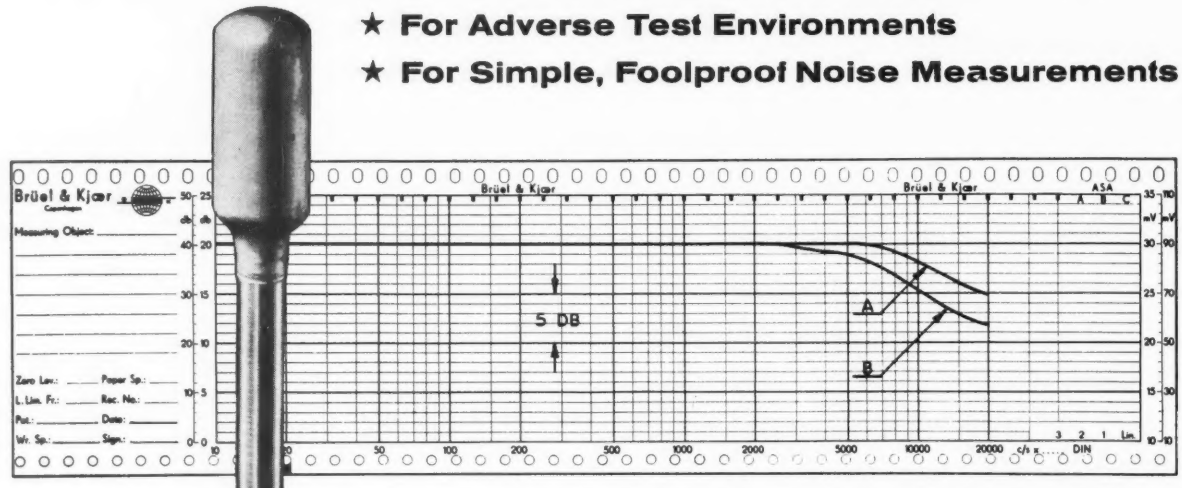
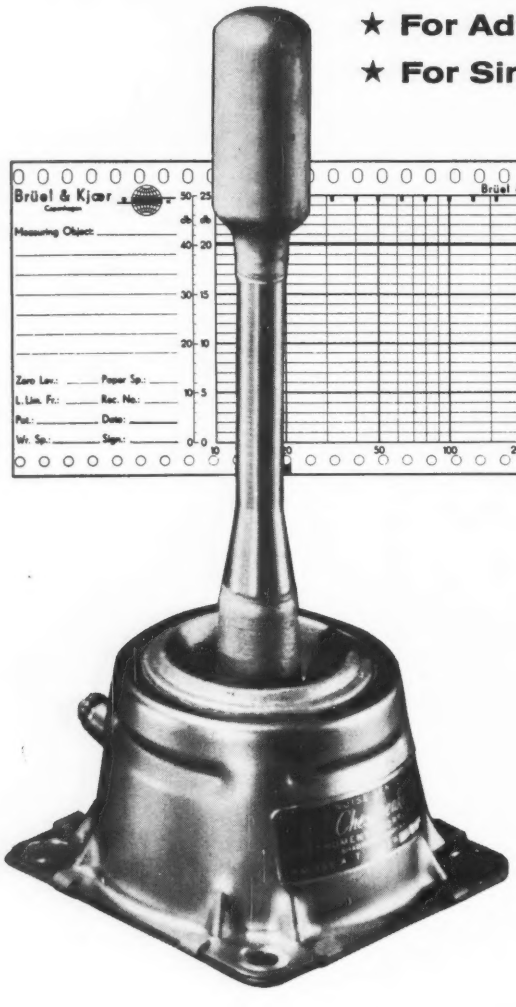
★ **For Adverse Test Environments**

★ **For Simple, Foolproof Noise Measurements**



A. Typical Free Field Response for Model NM 125

B. Typical Free Field Response for Model NM 135



Model NM 125 — 4 inches high
Model NM 135 — 5¾ inches high

measure "in flight" and test stand acoustic environments as simply as acceleration

★ **Self-Generating Sensor**

★ **Low Sensitivity to Shock & Vibration**

★ **Temperature Range −75° to +500° F.**

★ **Dynamic Range 90 to 200 db.**

★ **Unaffected by Weather**

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The skill and know-how gained from the coordination of Associated's two divisions through "feedback" of information assures the proper utilization of test equipment within the Testing Division and the proper design of environmental test equipment within the Manufacturing Division.

Write for illustrated literature!

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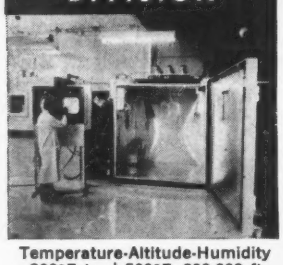
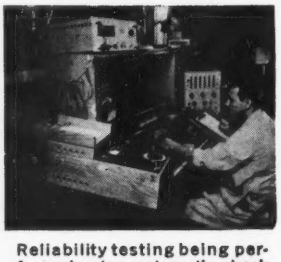


Temperature-Altitude-Humidity −300°F to +500°F, 200,000 ft., 5% to 100% RH, in one of more than 30 chambers available for your testing.

Sawtooth shock test being performed on a Shock Test Machine developed by Associated.

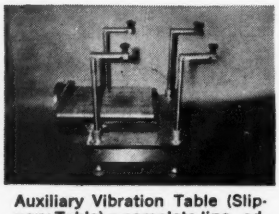
Explosion-proof testing in accordance with specifications MIL-E-005272B, MIL-E-5272C, MIL-E-5422D, etc.



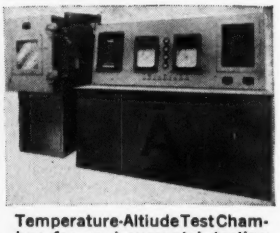
Reliability testing being performed using automatic check out panels.

MANUFACTURING DIVISION

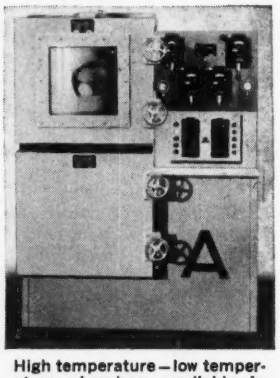
All Lucite Salt Spray Chamber built to perform tests in accordance with specifications MIL-E-5272A, QQ-M-151A, MIL-STD-202A, etc.



Auxiliary Vibration Table (Slippery Table) a complete line, adjustable in height, for use with any vibration machine.



Temperature-Altiude Test Chamber for environmental testing within the range of −300°F to +1200°F and from sea level up to 350,000 feet.



High temperature – low temperature chambers available in single or dual units for testing range of −300°F to +1200°F.

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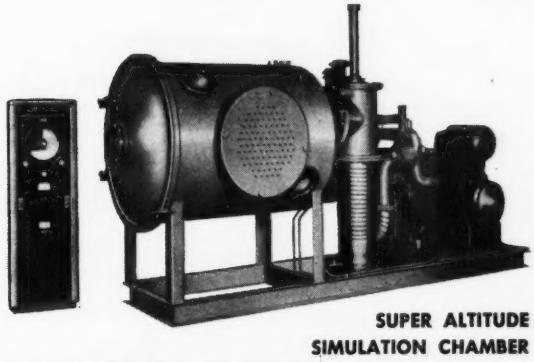

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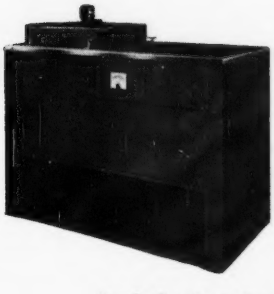

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- Heating cycles available to 300°F
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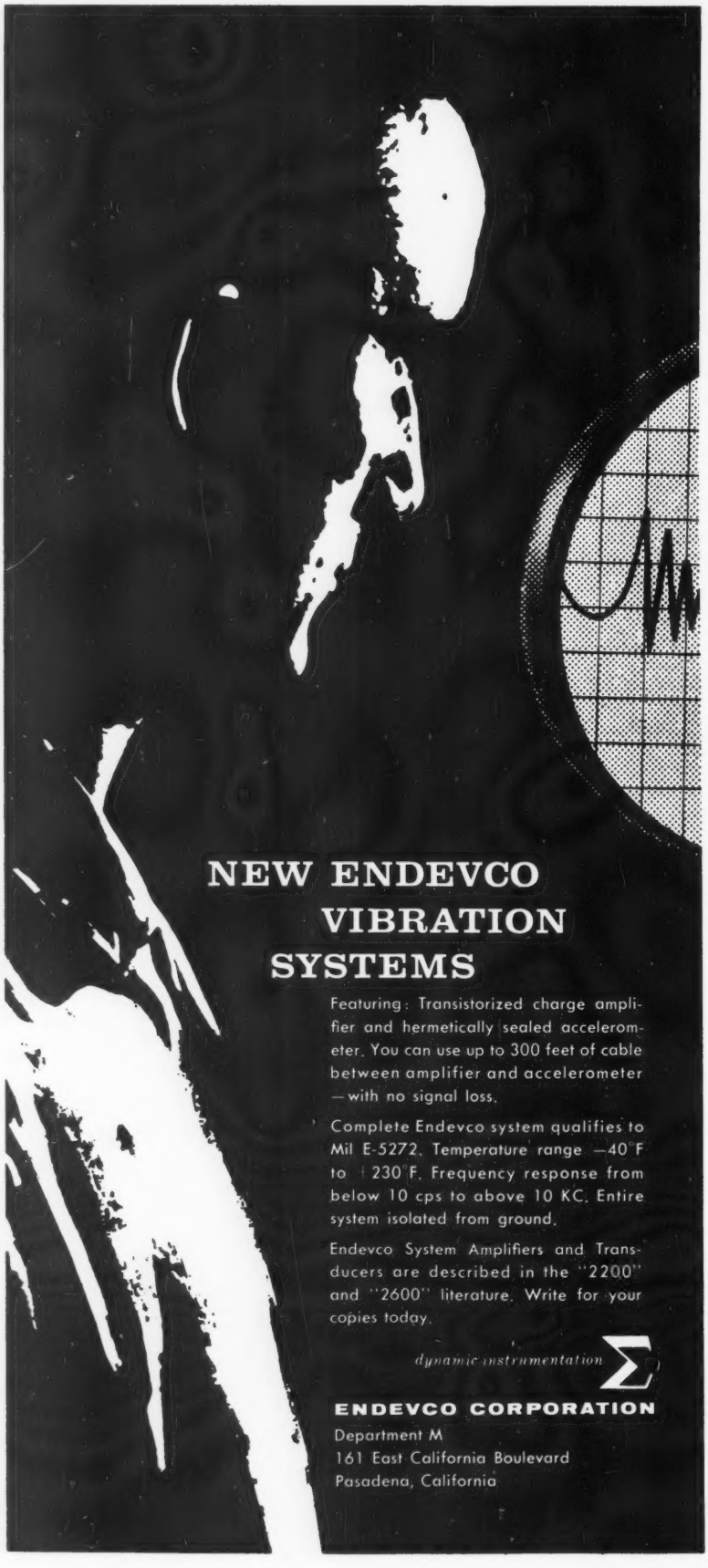
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APPLICATIONS

For further information regarding membership write to The Institute of Environmental Sciences, Box 191, Mt. Prospect, Illinois. Attention: Russell Lowe, Vice President, Membership.

extends low range of Genisco rate-of-turn table to 0.0001° per second

Ball-disc-differential device permits low threshold measurements of the newest, ultra-sensitive rate gyros

Rates of the Genisco Model C181 Rate-of-Turn Table are infinitely variable from 0.01° to 1200° per second. This range is ample for most applications. However, calibration of today's sophisticated missile and aircraft gyros requires a very small but known angular rate. The new Micro-Rate Accessory extends the low range of Model C181 to 0.0001° per second, or *approximately one revolution of the turntable every 42 days!* Now gyros can be accurately calibrated over a range of from 0.0001° to 1200° per second, and without remounting the test specimen.

Various rate monitoring accessories available—Rates of the basic machine can be monitored by an indicator drum, strobe systems, a magnetic pulse generator, or a photoelectric pulse generator. Since the reduction ratio of the Micro-Rate Accessory is 100:1, its rate is obtained by dividing the rate of the basic machine by 100. With the photoelectric pulse generator accessory and a suitable electronic counter, rates as low as 0.0001° per second can be read.

Complete information on both the Model C181 and the Micro-Rate Accessory is available from your Genisco representative. If you prefer, write directly to the Director, Mechanical Div.,

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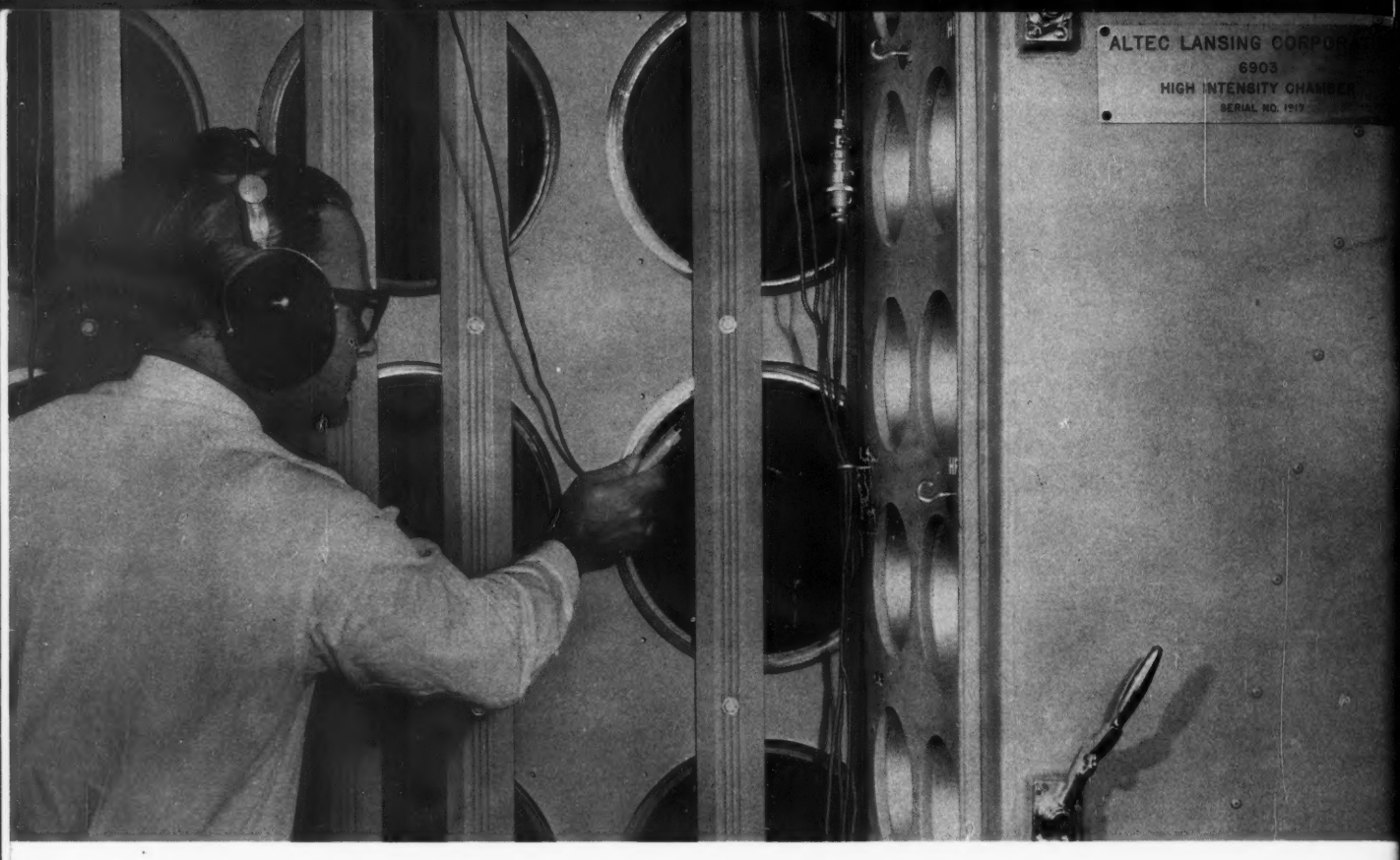

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a destructive, powerful force . . . a useful, versatile tool!

The destructive forces of high intensity sound – both in vibration and heat produced – are now better understood and better controlled through the use of testing chambers such as this latest Ling-Altec Reverberation Chamber.

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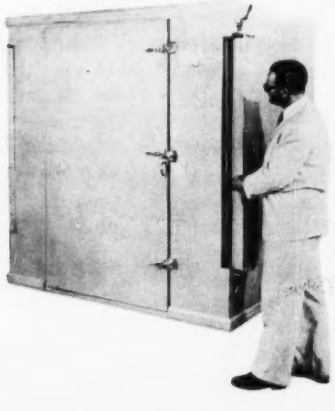
Even greater forces can be produced in Ling-Altec Plane Wave Tubes with air modulated devices which concentrate the power of high intensity sound many times.

These developments are a part of the continuing leadership of the Ling-Altec combination – high power electronics and high intensity sound!



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